DOCUMENT RESUME

ED 263 381 CE 042 897

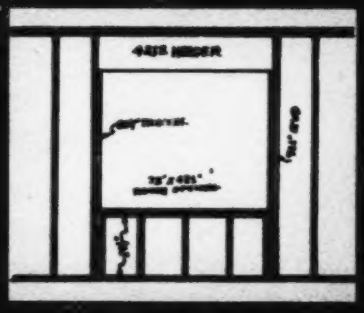
| | |
|---|---|
| TITLE | Rough Framing. Course in Carpentry. Workbook and Tests. |
| INSTITUTION | California State Dept. of Education, Sacramento. Bureau of Publications. |
| PUB DATE | 83 |
| NOTE | 56p.; For a related document, see CE 042 898. |
| AVAILABLE FROM | Publications Sales, California State Department of Education, P.O. Box 271, Sacramento, CA 95802-0271 ($3.50). |
| PUB TYPE | Guides - Classroom Use - Materials (For Learner) (051) |
| EDRS PRICE | MF01 Plus Postage. PC Not Available from EDRS. |
| DESCRIPTORS | *Apprenticeships; Behavioral Objectives; *Building Trades; *Carpentry; *Construction (Process); Learning Activities; Postsecondary Education; *Trade and Industrial Education; *Woodworking; Workbooks |
| IDENTIFIERS | California |

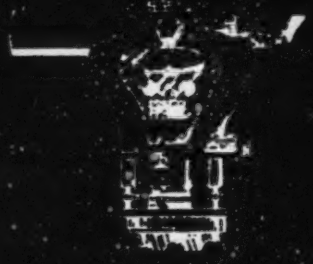
ABSTRACT

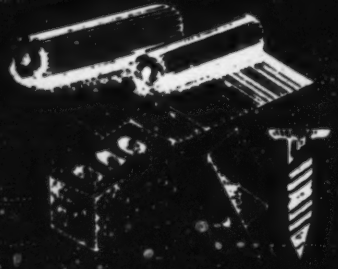
This student workbook, which is intended for apprentices in the carpentry trade, deals with rough framing. The workbook is divided into two sections: the first half consists of instructional materials and study guides, and the second half consists of multiple-choice unit tests on the topics covered in the first part of the book. The following topics are addressed: basic framing systems, framing lumber, horizontal layout, erecting framed walls, and ceiling joists. Lists of required and recommended instructional materials are provided, as well as six tests on each section of the booklet. (MN)

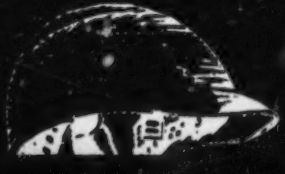
**********
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
**********

# ROUGH FRAMING









U.S. DEPARTMENT OF EDUCATION
NATIONAL INSTITUTE OF EDUCATION
EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)

☐ This document has been reproduced as received from the person or organization originating it.

☐ Minor changes have been made to improve reproduction quality.

• Points of view or opinions stated in this document do not necessarily represent official NIE position or policy.

"PERMISSION TO REPRODUCE THIS MATERIAL IN MICROFICHE ONLY HAS BEEN GRANTED BY

T Smith

TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)."

A column labeled "Date Assigned" is provided at the right-hand side of each page number of the workbook and tests sections in the contents. Whenever your instructor assigns a topic or test, write the date in the appropriate blank. When you have completed the assignment satisfactorily, your instructor should place his or her initials next to the assignment date. If this procedure has been followed, and you should transfer from one school to another, you will have an accurate record of the work you have completed. This procedure is intended to ensure that you complete each topic and to ensure that you do not have to duplicate work on topics already studied.

To provide other school records needed, be sure to fill in the blanks below, giving your name, home address, and telephone number. Then ask your instructor to fill in the official date of your enrollment in the class and to sign where indicated.

NAME _____

ADDRESS _____

_____ PHONE _____

DATE ENROLLED _____

INSTRUCTOR(S) _____

_____



BEST COPY AVAILABLE

# Course in Carpentry

# ROUGH FRAMING

## Workbook and Tests

Prepared under the direction of the

**Carpenters' Statewide Joint Apprenticeship and Training Committee**
**Carpentry Curriculum Revision Committee**

and the

**Bureau of Publications, California State Department of Education**

## Publishing Information

Copyright © 1976, 1983
by
California State Department of Education

This publication was edited by Bob Merklein, Assistant Editor; prepared for photo-offset production by the staff of the Bureau of Publications, California State Department of Education; and published by the Department, 721 Capitol Mall, Sacramento, CA 95814.

Printed by the Office of State Printing
and distributed under the provisions
of the Library Distribution Act

---

*Course in Carpentry: Rough Framing* is one of a series of 20 titles in the carpentry series containing workbook and tests within one volume. The titles available, together with year of publication or revision and selling price, are as follows:

| | | |
|---|---|---|
| The Apprentice Carpenter and the Trade | (Rev. 1981) | $2.25 |
| Blueprint Reading | (1975) | 2.50 |
| Blueprint Reading, Commercial and Industrial | (1976) | 2.00 |
| Builder's Level and Transit-Level | (Rev. 1981) | 2.50 |
| California Contemporary House Plans | (1975) | 1.50 |
| Concrete | (1976) | 2.50 |
| Exterior Finish | (Rev. 1981) | 2.50 |
| Form Detailing, Construction, and Erection | (1976) | 2.50 |
| Foundations and Floors | (1975) | 2.25 |
| Heavy Timber Construction | (1977) | 2.50 |
| Interior Finish | (Rev. 1981) | 2.50 |
| Materials of Construction | (1975) | 2.00 |
| Mathematics | (Rev. 1983) | 3.90 |
| Precast and Prestressed Concrete | (1976) | 2.25 |
| Roof Framing | (1976) | 2.50 |
| Rough Framing | (Rev. 1983) | 3.50 |
| Safety | (1975) | 2.00 |
| Site Work | (Rev. 1983) | 3.50 |
| Stair Building | (Rev. 1982) | 2.25 |
| Welding | (1976) | 2.25 |

In addition, the California State Department of Education publishes workbooks and testbooks for apprenticeship instruction in some 23 other trades.

Sales tax should be added to the above prices on all orders from California purchasers. Remittance or purchase order must accompany order. Purchase orders without checks are accepted only from government agencies in California. Phone orders are not accepted.

Orders should be directed to:

Publications Sales
California State Department of Education
P.O. Box 271
Sacramento, CA 95802

A complete list of publications available from the Department may be obtained by writing to the address listed above.

Questions and comments pertaining to existing apprenticeship instructional materials or to the development and production of new materials for apprenticeable trades should be directed to:

Theodore R. Smith or Bob Klingensmith
Bureau of Publications
California State Department of Education
721 Capitol Mall
Sacramento, CA 95814
(916) 445-7608

# Contents


Foreword ..... v
Preface ..... vii
Acknowledgments ..... viii


## Workbook


| ROUGH FRAMING | | Page | Date assigned |
|---|---|---|---|
| Topic | | | |
| 1 | Basic Framing Systems | 1 | |
| 2 | Framing Lumber | 7 | |
| 3 | Horizontal Layout | 14 | |
| 4 | Vertical Layout | 18 | |
| 5 | Erecting Framed Walls | 23 | |
| 6 | Ceiling Joists | 30 | |
| INSTRUCTIONAL MATERIALS | | 34 | |


## Tests


| ROUGH FRAMING | | Page | Score |
|---|---|---|---|
| Topic | | | |
| 1 | Basic Framing Systems | 37 | |
| 2 | Framing Lumber | 39 | |
| 3 | Horizontal Layout | 41 | |
| 4 | Vertical Layout | 43 | |
| 5 | Erecting Framed Walls | 45 | |
| 6 | Ceiling Joists | 47 | |

# Foreword

Welcome to the world of apprenticeship. Congratulations, too, on having selected carpentry as your area of specialization, for you have chosen a time-honored and essential profession. Many formidable challenges lie ahead of you, both on the jobsite and in your related-instruction classes, but I believe that the pride and excitement you will experience and the more tangible rewards you will reap will greatly outweigh the difficulties inherent in meeting those challenges.

As an apprentice in the four-year carpentry apprenticeship program, you have a unique opportunity to receive excellent training in all aspects of the trade. I urge you to take full advantage of that opportunity and to apply yourself diligently in each phase of the training program, because in today's tight job market, workers who have mastered the full range of skills have the best chance of keeping themselves employed.

The role of the Department of Education in providing carpentry apprenticeship instructional materials goes back many years. The Department is proud of that role and pleased to be able to continue its cooperative association with labor and management in keeping *Rough Framing* and the other volumes in the Course in Carpentry series up to date. On behalf of the Department, I wish you great success as an apprentice and as a journey-level carpenter.

Bill Honig

*Superintendent of Public Instruction*

# Preface

The California State Department of Education, through the Bureau of Publications, provides for the development of instructional materials for apprentices under provisions of the California Apprentice Labor Standards Act. These materials are developed through the cooperative efforts of the Department of Education and employer-employee groups representing apprenticeable trades.

*Rough Framing,* which was first published in 1976, was planned and prepared under the direction of the Carpenters' Statewide Joint Apprenticeship and Training Committee and the Carpentry Curriculum Revision Committee. Many individuals representing employers, employees, and public education contributed to the 1976 publication. Those representing central and northern California included James Brooks, Charles Hanna, Gordon Littman, Charles Royalty, Hans Wachsmuth, Bill Walker, and Jimps Wilcox. Those representing the Los Angeles area included Tom Benson, Creighton Blenkhorn, John Cox, Allen Kocher, and Al Preheim. San Diego representatives were Paul Cecil, Jess Dawson, Robert Moorhouse, and Billy Williams. Bob Klingensmith, Publications Consultant, Apprenticeship, directed the work on this 1983 edition for the Bureau of Publications.

This publication is one of a series of individually bound units of instruction for carpentry apprenticeship classes. It consists of two parts—a workbook section and a tests section. A test is provided for each topic in the workbook section, and each test sheet is perforated and arranged so that it can be easily removed from the book at the discretion of the instructor without disturbing any other test. These books reflect the continuing cooperative effort of labor, management, local schools, and the Department of Education to provide the best instructional materials for California apprenticeship classes. They are dedicated to excellence in the training of carpenter apprentices.

GILBERT R. MARGUTH, JR.
*Deputy Superintendent*
*for Administration*

THEODORE R. SMITH
*Editor in Chief*
*Bureau of Publications*

# Acknowledgments

The Department of Education expresses its gratitude to the following manufacturers and associations within the construction industry who contributed valuable technical information, drawings, and photographs used in the carpentry series.

American Plywood Association
American Technical Society
Duo-Fast Corporation
Formica Corporation
National Forest Products Association
Red Cedar Shingle and Handsplit Shake Bureau
Republic Builders Products Corporation
Rockwell International Corporation, Power Tool Division
Schlage Lock Company
Stanley Tools
TECO Wood Fastenings
United States League of Savings Associations
Von Duprin Incorporated
Western Wood Products Association

# Rough Framing

## TOPIC 1 — BASIC FRAMING SYSTEMS

This topic is planned to help you answer the following questions:

- **What basic framing systems are used today?**
- **What are the names of the various parts of each framing system?**
- **What are the advantages and disadvantages of each framing system?**

As a carpenter you must be able to frame many types of buildings and have a thorough understanding of the various framing systems used in the building industry today. And you need to know the names of the different components of the structure so that you can communicate effectively with your supervisor and fellow workers.

### Platform Framing

Platform framing is the most widely used framing system in the construction industry because of its versatility, simplicity, and low cost. In this system the wall frames are assembled on the rough floor, which provides a convenient platform on which to work. The wall frames are assembled complete with window and door openings and then raised into position and braced and blocked if required. Corners are formed when the ends of the frames are mated and nailed to corner studs.

#### Framing Members

The various parts of the wall are called framing members. The following are some of the more common framing members that carpenters should know.

*Plate.* The top plate and bottom (sole) plate are horizontal 2 x 4 members that are placed at the top and bottom of the studs in the wall frame. The bottom plate acts as a base for the entire frame, while the top plate serves as a base for the attic joists and roof rafters.

*Header.* The header is a horizontal structural member that carries the load of the ceiling and roof over the door and window openings. Although a smaller header could be used to carry the load, the 4 x 12 header is generally used in conventional framing.

*Rough sill.* The rough sill, which is usually horizontal, is the lowest member in a window rough opening. A single 2 x 4 sill is adequate for a window less than 4 feet in width, but a double sill is required for windows 4 feet or more in width.

*Trimmer.* The trimmer is used to provide support for the header and to stiffen the framework at the sides of the window. Double trimmers may be required when the opening exceeds 6 feet.

*Regular stud.* A regular stud is a vertical member (2 x 4) that is used in the framework of the wall.

*Cripple stud.* A cripple stud, which is shorter than a regular stud, supports the rough window sill and provides nailing surfaces for interior and exterior finishes. Also, cripple studs are installed between the header and top plate when needed. In the West the trimmer is sometimes called a cripple stud.

*Diagonal bracing.* Diagonal bracing is provided by 1 x 4 let-in members; however, if $\frac{3}{8}$-inch-thick plywood or other approved sheathing is used, the let-in bracing may be omitted.

*Stud bridging.* Stud bridging (fire blocking) is required on walls more than 8 feet high and on all walls in multistory buildings that carry the floor load. It is not required in single-story buildings.

For code requirements and allowable spans for framing members, consult *Dwelling Construction Under the Uniform Building Code.* (See the Instructional Materials section on page 34.)

#### Precut Framing Members

Platform framing lends itself to the use of precut framing members—studs, trimmers, cripples, rough window sills, and standard bridging. In preparing the lumber list, the supervisor or builder gives the quantity and length of the items needed, and they are cut to length at the lumberyard or mill. These precut items are usually put into a convenient bundle and delivered to the jobsite. For example, the following

items are bundled together for a window unit: header, rough sill, cripples, and trimmers. The window size or header length is then written on the bundle with lumber crayon (Kiel). This method precludes any time-consuming search and sorting at the jobsite. Carpenters should note that it is not feasible to precut plates, diagonal bracing, or special stud bridging. These items should be cut to length on the job.

**Prefabricated Wall Sections**

Some builders use prefabricated wall sections that are assembled at the factory and delivered to the site on large flatbed trucks. The extent of prefabrication varies. Sometimes only windows and exterior wall finish are installed at the factory. In other cases, the wall is complete with wiring, insulation, exterior and interior finishes, doors, and windows. Prefabrication experiments have been conducted in assembling entire rooms, and in some cases entire houses, at the factory.

Most prefabrication efforts have not resulted in a significant savings because of the cost of shipping, handling, and crane rental. However, a notable exception is the roof truss. The factory-built truss has proven to be economical for tracts, apartments, and other uses, provided the roof design is not too complex and the job is large enough to warrant factory assembly.

Platform framing in which precut components are assembled on the job is the most economical type of framing system.

## Post and Beam Framing

The post and beam framing system, although not as economical as platform framing, is used mainly for aesthetic reasons. The exposed posts, beams, and roof planking give a handsome appearance and an open feeling to the building.

This system is characterized by posts set at intervals of 4, 6, or 8 feet. A longitudinal beam that rests on top of the posts supports the transverse roof beams (rafters) at the wall line. The roof beams are supported at the center of the building by a ridge beam. Tongue-and-groove planking is usually used for the roof decking.

Unlike platform framing, the post and beam system is framed "in place." The posts are raised into position, plumbed, and braced. The beams are then set on top of the posts and attached with heavy metal framing anchors or with steel rods driven through prebored holes. Carpentry work must be done with great care, for all work is exposed, and any hammer marks or ill fitting joints will be permanent eyesores.

Precut components cannot be used in post and beam construction. Each piece must be exactly fitted for the sake of appearance. Even though this system has fewer wood members than platform framing, labor costs are usually greater.

Post and beam framing poses other difficulties that may increase the overall cost of the building. Modular construction does not provide much flexibility for the location of windows, doors, partitions, and the like, which may cause some wasted space. Such things as electrical wiring, plumbing pipes, and heating ducts are more difficult to run because there is no stud space, no attic, and in some cases no basement or crawl space beneath the floor. These problems can be solved, but the solutions frequently result in more expense. For example, costs are sometimes increased when framing members must be of "appearance grade" lumber that is free of defects such as large knots, pitch pockets, cupping, twisting, and stains or blemishes. Also, a building that is strictly post and beam must have steel rods and turnbuckles for lateral bracing, or some other approved system designed by an engineer.

## Modified Post and Beam Framing

Some of the difficulties previously mentioned can be overcome by using a modified post and beam system (Fig. 1-1). In this system, most of the building is constructed by regular platform framing, while post and beam framing is used in selected areas of the structure.

The limitations of modular construction can be minimized, for example, by having only the living room constructed with posts and beams. This modified system provides more space for wiring, plumbing, and heating. Also, the room arrangement is more flexible in that portion of the building where platform framing is used.

In modified post and beam framing, lateral bracing can be provided by 1 x 4 diagonal let-in braces or by plywood wall sheathing on the conventionally framed sections.

## Balloon Framing

Balloon framing is seldom used today because of the high labor costs associated with it. The system has continuous studs from the mudsill to the top plates just under the roof. The very tall walls (two story) can be framed on the ground and lifted into

place, but they are heavy and potentially dangerous to erect. The main advantage of balloon framing is that there is less shrinkage in the height of the building; hence, there may be less cracking of the plaster, stucco, or drywall and fewer problems if masonry veneer is used as an exterior wall finish from ground to roof. Because of its limited use, no erection details for balloon framing are given in this unit (see the Instructional Materials section on page 34).

### Metal Stud Systems

Engineers have designed metal stud systems using the principles of platform framing (Figs. 1-2 and 1-3). The components have the same names,

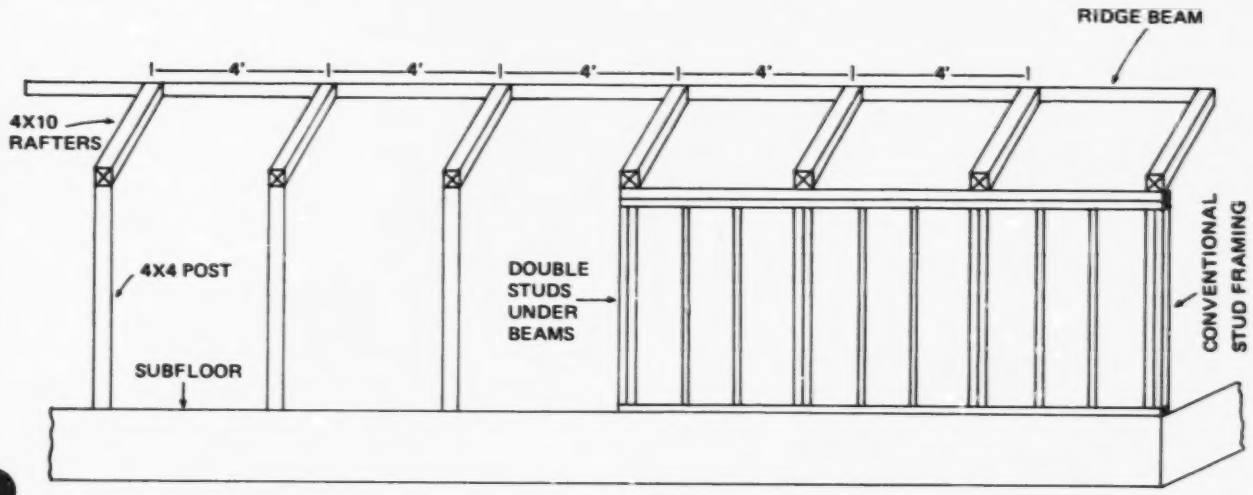



Fig. 1-1. Modified post and beam framing

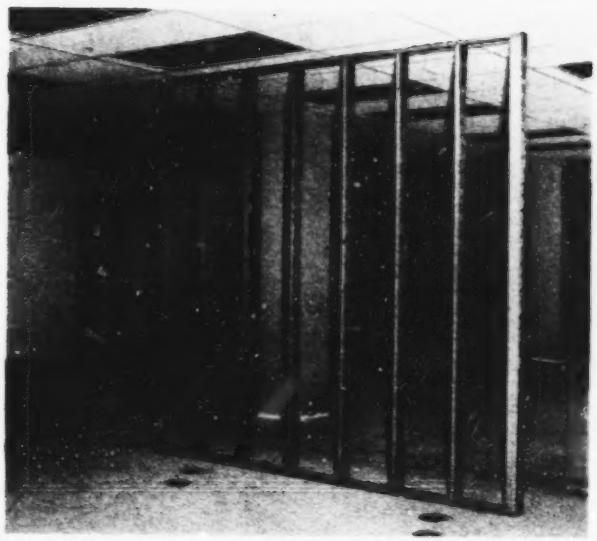


Fig. 1-2. Metal stud wall showing floor and ceiling runner attachments

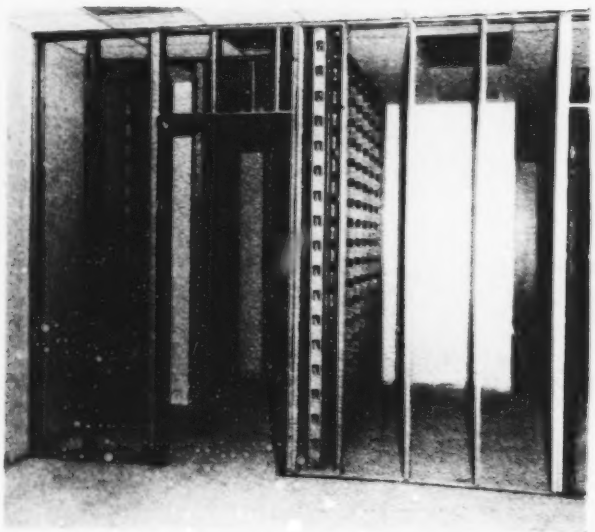


Fig. 1-3. Metal stud system with interlocking partition and metal door buck

such as studs, plates, headers, and bridging, and their functions are the same as in wood construction. Metal stud systems are experimental because the *Uniform Building Code* makes no provisions for them. An engineer must be hired to design and certify the structural soundness of each system.

Metal studs are slotted to permit electrical wiring and small piping to pass through them. Plates are of metal channels, and headers are made of metal. Lateral bracing may be provided by plywood that is attached with screws to the interior or exterior of the walls.

Metal framing derives its strength from the geometrical shape of the framing members. However, when metal framing is notched for piping or ducting, the structural integrity of the overall system is jeopardized because the members lose their strength. Wood is a marvelous material that can be grooved, notched, drilled, nailed into, and so forth, provided certain basic rules are followed. At present the material and labor costs for metal stud systems are greater than those for wood framing. It is unlikely that metal will ever entirely replace wood, but plastics (polymers) may some day compete with wood as technology develops and market conditions change.

Metal wall systems are commonly used in commercial and industrial buildings because of fire regulations.

Steel wall systems are generally nonload bearing. They are used to divide space but not to carry the loads of the ceiling, roof, or an upper floor. These loads are carried by reinforced concrete columns and beams or other noncombustible systems of great strength.

### Study Assignments

1. *Dwelling Construction Under the Uniform Building Code* (1982 edition). Whittier, Calif.: International Conference of Building Officials, 1982. Read pp. 18—20 and study Figs. 6 and 7 on pp. 79 and 80, respectively.
2. Walter E. Durbahn and Elmer W. Sundberg, *Fundamentals of Carpentry,* Vol. 2, *Practical Construction* (Fifth edition). Chicago: American Technical Society, 1977. Read Chapter 4, "Wall and Floor Framing," and study Figs. 4-1, 4-2, 4-7, 4-8, 4-10, 4-29, 4-81, and 4-82.
3. *California Contemporary House Plans.* Sacramento: California State Department of Education, 1975. Use sheets 7/14 and 8/14 to study wall and ceiling framing and lumber sizes.

## TOPIC 1 – BASIC FRAMING SYSTEMS

### Study Guide (Part 1)

Determine the correct word for each numbered blank in the sentence, and write it in the corresponding blank at the right.

1. Platform framing is the most widely used framing system because of its 1 , 2 , and 3 . — 1. _____ 2. _____ 3. _____

2. In platform framing, the walls are assembled on the 4 . — 4. _____

3. Regular studs extend from the 5 plate to the 6 plate. — 5. _____ 6. _____

4. Trimmers extend from the bottom plate to the underside of the 7 . — 7. _____

5. The window rough sill is supported by 8 studs. — 8. _____

6. Generally 9 x 10 headers are used in conventional framing to save labor. — 9. _____ 10. _____

7. Diagonal bracing may be provided by let-in 11 x 12 . — 11. _____ 12. _____

8. Windows that are 13 feet or wider must have 14 sills. — 13. _____ 14. _____

9. Platform framing lends itself to the use of 15 framing members, such as 16 , 17 , 18 , 19 , and 20 . — 15. _____ 16. _____ 17. _____ 18. _____ 19. _____ 20. _____

10. Balloon framing is seldom used today because of the 21 costs associated with it. — 21. _____

## Study Guide (Part 2)

At the left below is a list of framing members, and in the center below are the uses of these framing members. Match each framing member with its use by writing the correct letter in the corresponding blank at the right.

| | | |
|---|---|---|
| 1. Sole plate | a. Provides lateral bracing | 1. _____ |
| 2. Regular stud | b. Full-length stud nailed to header | 2. _____ |
| 3. King stud | c. Partial stud supporting header | 3. _____ |
| 4. Trimmer | d. Short stud under window | 4. _____ |
| 5. Cripple stud | e. Member that supports load over door or window | 5. _____ |
| 6. Rough sill | f. Horizontal member under stud at the floor | 6. _____ |
| 7. Header | g. Horizontal member at top of studs | 7. _____ |
| 8. Diagonal brace | h. Horizontal member above top plate | 8. _____ |
| 9. Top plate | i. Horizontal member at bottom of window opening | 9. _____ |
| 10. Doubler | j. Nailing surface for interior and exterior wall finishes | 10. _____ |

## ROUGH FRAMING

## TOPIC 2 – FRAMING LUMBER

This topic is planned to help you answer the following questions:

- **What kinds of lumber are commonly used for framing?**
- **What grades of lumber are used for the different parts of the building?**
- **How do the various kinds of lumber compare in strength?**
- **How does the carpenter determine what size lumber to use?**
- **How does the carpenter order framing lumber?**

Carpenters must be able to select the best lumber for use in the various parts of the building. You must, therefore, know about such things as the kinds, sizes, lengths, and grades of framing lumber. It is important to know something about the comparative strengths of framing lumber to ensure that the building members are structurally adequate. You must also know how to order the least expensive lumber that meets job specifications and code requirements.

### Kinds of Framing Lumber

Douglas fir is by far the most widely used framing lumber in the West. This wood is strong, readily available, and less expensive than other woods of equal strength. Many buildings are framed entirely of Douglas fir, including the mudsills if they are pressure treated to prevent rot and termite invasion.

White fir, hemlock, larch, and redwood also are used in the West for framing. Larch is as strong as Douglas fir, but it is scarcer and more expensive. White fir and hemlock are generally cheaper than Douglas fir, but they are not as strong. The use of white fir and hemlock is limited to framing members such as plates and studs, which do not require the great strength of Douglas fir. Redwood is commonly used for mudsills because it is highly resistant to rot and somewhat resistant to termites. Pressure-treated fir is generally cheaper than redwood and has better resistance to rot and termites. Building codes require that either foundation grade redwood or pressure-treated fir be used wherever wood is in contact with concrete, such as mudsills, pier blocks, or studs touching a concrete wall. Redwood is also used for studs in framing. Redwood studs are cheap and, although they are not as strong as Douglas fir, white fir, larch, or hemlock, they meet the minimum requirements of the *Uniform Building Code.*

### Lumber Sizes

When logs are first cut at the sawmill, the lumber is produced in "nominal" or "rough" sizes; for example, the 2 x 4 actually measures 2 inches by 4 inches or slightly larger. However, in subsequent operations the 2 x 4 is planed and surfaced to its finished or actual size of 1½ inches by 3½ inches. Therefore, when carpenters use the term *2 x 4* on the job, they are referring to the nominal dimensions of the lumber. Framing lumber is referred to as "S4S," which means surfaced on four sides. The nominal and actual sizes of some representative framing members are given in Table 2-1.

**TABLE 2-1**

Nominal and Actual Lumber Dimensions

| Nominal dimensions (rough) | Actual dimensions (S4S) |
|---|---|
| 1 x 4 | ¾" x 3½" |
| 2 x 4 | 1½" x 3½" |
| 2 x 6 | 1½" x 5⅜" |
| 4 x 8 | 3½" x 7¼" |
| 4 x 12 | 3½" x 11¼" |
| 3 x 4 | 2½" x 3½" |

Lumber is sometimes ordered in the rough form for particular jobs. Usually this material is used for appearance, such as a rustic atmosphere in a restaurant. For other specialized applications lumber may be used that is left rough on one or more sides and surfaced on the other sides. The abbreviations used for this purpose are given in Table 2-2. The term *side* means the widest surface or face of the board, while the term *edge* means the narrowest dimension.

The term *saw sized* denotes something different from rough lumber. This lumber is run through a special machine that has a blade similar to that of a

TABLE 2-2

Lumber Abbreviations

| Abbreviation | Meaning |
|---|---|
| S1E | Surfaced one edge |
| S1S1E | Surfaced one side and one edge |
| S1S2E | Surfaced one side and two edges |
| S2S1E | Surfaced two sides and one edge |
| S4S | Surfaced four sides |
| RO | Rough (all four sides) |
| S/S | Saw sized |

band saw but is much wider. The finish lumber has a coarse texture with a pattern that runs across the width of the board. Saw-sized lumber is sometimes used as fascia or other trim, siding or paneling, or the underside of exposed roof decking.

### Lumber Lengths

Framing lumber normally comes in lengths of 8, 10, 12, 14, 16, 18, and 20 feet. If 6-foot lengths are needed, two pieces can be cut from a 12-foot length. If odd numbered lengths are needed, such as 7 or 9 feet, they can be cut from 14- or 18-foot pieces. Lengths over 20 feet are not normally stocked by most lumberyards, but they are available at extra cost on special order.

### Lumber Grades

In addition to knowing the best kind of lumber to use for a certain purpose, you must be familiar with the system used to grade lumber for strength and appearance. Over the years different systems have been used for grading lumber; the one currently in use was officially adopted late in 1970. Most lumber mills use this system, but there may be some exceptions. If you are in doubt, you should consult your lumber dealer about the meaning of the grade stamps that appear on framing lumber.

Each piece of framing lumber is graded, either visually or by machine. When it is done by a person, that individual must be very experienced and have a good eye. The grader must carefully but quickly look at each piece, noting the size, location, and type of knots and other defects. In accordance with standards set forth in the grading rules of the Western Wood Products Association, the lumber is stamped with one of the grades shown in Table 2-3 or Table 2-4.

Tables 2-3 and 2-4 were extracted from the more complete listing of lumber grades and species given in *Dwelling Construction Under the Uniform Build-*

TABLE 2-3

Lumber Grades for Douglas Fir and Larch 2 x 4s and Smaller

| Grade | Description | 1. Maximum fiber stress<br>2. Modulus of elasticity |
|---|---|---|
| Appearance | Free of blemishes, twists, curls, heart center, and the like. Small, tight knots. Very strong and expensive. | 1. 1200 (floor); 1500 (roof)<br>2. 1.5 million psi |
| Construction | Knots are small and tight. Strong. Less expensive than Appearance grade. | 1. 1200 (floor); 1500 (roof)<br>2. 1.5 million psi |
| Standard | Knots are larger than those in Construction grade, and some may be slightly loose. Not as strong as and less expensive than Construction grade. | 1. 675 (floor); 840 (roof)<br>2. 1.5 million psi |
| Utility | Large knots, many of them loose. Not as strong as Standard grade. Not suitable for plates, joists, or rafters. | 1. 325 (floor); 410 (roof)<br>2. 1.5 million psi |
| Studs | This is a special grade for use as wall studs. Strength and quality midway between Construction and Standard grades. | 1. 925 (floor); 1160 (roof)<br>2. 1.5 million psi |

TABLE 2-4

Lumber Grades for Douglas Fir and Larch 2 x 6s and Wider

| Grade | Description | 1. Maximum fiber stress<br>2. Modulus of elasticity |
|---|---|---|
| Appearance | Free of blemishes, twists, curls, heart center, and the like. Small, tight knots. Very strong and expensive. | 1. 1750 (floor); 2190 (roof)<br>2. 1.8 million psi |
| No. 1 | Knots are small and tight. Very strong. Less expensive than Appearance grade. | 1. 1750 (floor); 2190 (roof)<br>2. 1.8 million psi |
| Dense No. 2 | Dense and fine grain. Larger knots out, most are tight. Less expensive than No. 1. | 1. 1700 (floor); 2120 (roof)<br>2. 1.7 million psi |
| No. 2 | Coarser grain and not as dense. Larger knots, with some that are loose. Less expensive than Dense No. 2. | 1. 1450 (floor); 1810 (roof)<br>2. 1.7 million psi |
| No. 3 | Larger knots and more that are loose. Not as strong or expensive as No. 2. | 1. 850 (floor); 1060 (roof)<br>2. 1.5 million psi |

*ing Code,* Table 25-A-1. You should become thoroughly familiar with this publication, which contains most of the parts of the *Uniform Building Code* that apply to home construction.

The right-hand columns in tables 2-3 and 2-4 give some important information about the strength and stiffness of the lumber. Carpenters use the terms *maximum fiber stress* and *modulus of elasticity* frequently when they determine the maximum span for a joist or a rafter. Maximum fiber stress indicates the strength of lumber when it is subjected to loads that cause bending. The modulus of elasticity is a measure of how readily a piece of lumber regains its original form after it has been subjected to a load.

### Use of Span Tables

The allowable spans for ceiling joists used in residences are listed in Table 2-5. If you had to find the maximum allowable span for No. 1 Douglas fir (DF) 2 x 6 ceiling joists that are located on 12-inch centers, for example, you would do the following:

1. Find in Table 2-4 the modulus of elasticity for No. 1 DF, which is 1.8.
2. Use Table 2-5 as follows:
   a. Find 2 x 6 under the heading "Size."
   b. Find 12-inch centers under the heading "Spacing."
   c. Locate the number 20-3 at the intersection of the row after 12.0 and the column under 1.8. This number indicates that the maximum allowable span is 20 feet 3 inches.

Another factor that must be considered is maximum fiber stress. In Table 2-5 just under the maximum allowable span of 20-3 is the number 1220. This number indicates that the grade of lumber the carpenter selects must have a fiber stress of at least 1220. Table 2-4 shows that the maximum fiber stress for No. 1 DF roof members (no snow load) is 2190, which is no more than adequate. Therefore, you can be sure that a No. 1 DF 2 x 6 ceiling joist will span 20 feet 3 inches.

This procedure may seem complicated at first, but with practice you should be able to use the span tables quickly and reliably.

The maximum spans for window and door headers for one-story buildings are given in Table 2-6. Although smaller headers may be used, it is more economical to use 4 x 12 headers for doors and windows in conventional framing because short cripple studs do not have to be cut and nailed above the header. For openings smaller than 12 feet, it is permissible to use No. 3 or Utility grade 4 x 12 headers. This is often done to reduce costs.

Appearance grade lumber is generally used for post and beam construction because the lumber is exposed, and beauty is a prime consideration. No span tables are available for this type of construction; therefore, the sizes of the beams and rafters must be determined by a licensed architect or engineer.

Carpenters usually do not encounter problems with buildings that have post and beam construction, because in most cases the sizes of these structural members have been indicated on the plans by the

architect. However, if you should encounter a situation where you must determine what size beam or rafter to use, consult the local building inspection department or a licensed architect or engineer.

### Comparative Strengths of Framing Lumber

Table 2-7 lists the common kinds of framing lumber used in the West and gives the maximum span of ceiling joists spaced on 16-inch centers.

**TABLE 2-5**

Allowable Spans for Ceiling Joists

| Joist Size (in.) | Joist Spacing (in.) | Modulus of Elasticity, "E", in 1,000,000 psi | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 0.8 | 0.9 | 1.0 | 1.1 | 1.2 | 1.3 | 1.4 | 1.5 | 1.6 | 1.7 | 1.8 | 1.9 | 2.0 | 2.2 |
| 2 x 4 | 12.0 | 9-10<br>710 | 10-3<br>770 | 10-7<br>830 | 10-11<br>880 | 11-3<br>930 | 11-7<br>980 | 11-10<br>1030 | 12-2<br>1080 | 12-5<br>1130 | 12-8<br>1180 | 12-11<br>1220 | 13-2<br>1270 | 13-4<br>1310 | 13-9<br>1400 |
| | 16.0 | 8-11<br>780 | 9-4<br>850 | 9-8<br>910 | 9-11<br>970 | 10-3<br>1030 | 10-6<br>1080 | 10-9<br>1140 | 11-0<br>1190 | 11-3<br>1240 | 11-6<br>1290 | 11-9<br>1340 | 11-11<br>1390 | 12-2<br>1440 | 12-6<br>1540 |
| | 24.0 | 7-10<br>900 | 8-1<br>970 | 8-5<br>1040 | 8-8<br>1110 | 8-11<br>1170 | 9-2<br>1240 | 9-5<br>1300 | 9-8<br>1360 | 9-10<br>1420 | 10-0<br>1480 | 10-3<br>1540 | 10-5<br>1600 | 10-7<br>1650 | 10-11<br>1760 |
| 2 x 6 | 12.0 | 15-6<br>710 | 16-1<br>770 | 16-8<br>830 | 17-2<br>880 | 17-8<br>930 | 18-2<br>980 | 18-8<br>1030 | 19-1<br>1080 | 19-6<br>1130 | 19-11<br>1180 | 20-3<br>1220 | 20-8<br>1270 | 21-0<br>1310 | 21-8<br>1400 |
| | 16.0 | 14-1<br>780 | 14-7<br>850 | 15-2<br>910 | 15-7<br>970 | 16-1<br>1030 | 16-6<br>1080 | 16-11<br>1140 | 17-4<br>1190 | 17-8<br>1240 | 18-1<br>1290 | 18-5<br>1340 | 18-9<br>1390 | 19-1<br>1440 | 19-8<br>1540 |
| | 24.0 | 12-3<br>900 | 12-9<br>970 | 13-3<br>1040 | 13-8<br>1110 | 14-1<br>1170 | 14-5<br>1240 | 14-9<br>1300 | 15-2<br>1360 | 15-6<br>1420 | 15-9<br>1480 | 16-1<br>1540 | 16-4<br>1600 | 16-8<br>1650 | 17-2<br>1760 |
| 2 x 8 | 12.0 | 20-5<br>710 | 21-2<br>770 | 21-11<br>830 | 22-8<br>880 | 23-4<br>930 | 24-0<br>980 | 24-7<br>1030 | 25-2<br>1080 | 25-8<br>1130 | 26-2<br>1180 | 26-9<br>1220 | 27-2<br>1270 | 27-8<br>1310 | 28-7<br>1400 |
| | 16.0 | 18-6<br>780 | 19-3<br>850 | 19-11<br>910 | 20-7<br>970 | 21-2<br>1030 | 21-9<br>1080 | 22-4<br>1140 | 22-10<br>1190 | 23-4<br>1240 | 23-10<br>1290 | 24-3<br>1340 | 24-8<br>1390 | 25-2<br>1440 | 25-11<br>1540 |
| | 24.0 | 16-2<br>900 | 16-10<br>970 | 17-5<br>1040 | 18-0<br>1110 | 18-6<br>1170 | 19-0<br>1240 | 19-6<br>1300 | 19-11<br>1360 | 20-5<br>1420 | 20-10<br>1480 | 21-2<br>1540 | 21-7<br>1600 | 21-11<br>1650 | 22-8<br>1760 |
| 2 x 10 | 12.0 | 26.0<br>710 | 27-1<br>770 | 28-0<br>830 | 28-11<br>880 | 29-9<br>930 | 30-7<br>980 | 31-4<br>1030 | 32-1<br>1080 | 32-9<br>1130 | 33-5<br>1180 | 34-1<br>1220 | 34-8<br>1270 | 35-4<br>1310 | 36-5<br>1400 |
| | 16.0 | 23-8<br>780 | 24-7<br>850 | 25-5<br>910 | 26-3<br>970 | 27-1<br>1030 | 27-9<br>1080 | 28-6<br>1140 | 29-2<br>1190 | 29-9<br>1240 | 30-5<br>1290 | 31-0<br>1340 | 31-6<br>1390 | 32-1<br>1440 | 33-1<br>1540 |
| | 24.0 | 20-8<br>900 | 21-6<br>970 | 22-3<br>1040 | 22-11<br>1110 | 23-8<br>1170 | 24-3<br>1240 | 24-10<br>1300 | 25-5<br>1360 | 26-0<br>1420 | 26-6<br>1480 | 27-1<br>1540 | 27-6<br>1600 | 28-0<br>1650 | 28-11<br>1760 |

**TABLE 2-6**

Maximum Spans for Window and Door Headers

| Lumber size | Species | Minimum grade | Maximum allowable span |
|---|---|---|---|
| 4 x 4 | DF | No. 2 | 4′ |
| 4 x 6 | DF | No. 2 | 6′ |
| 4 x 8 | DF | No. 2 | 8′ |
| 4 x 10 | DF | No. 2 | 10′ |
| 4 x 12 | DF | No. 2 | 12′ |
| 4 x 14 | DF | No. 1 | 16′ (commonly used for garage doors) |

The strongest framing lumbers are Douglas fir and larch, then hemlock and white fir, and finally redwood, which is the weakest. The grade stamp for hemlock and white fir (HEM-FIR) does not distinguish between the two species. The fact that both kinds of lumber have the same strength and have similar properties presents no problems.

### Framing-Lumber Orders

An important factor in building economically but properly is to order the least expensive framing lumber that meets all code requirements and job specifications. It is not always necessary to use the best grade of lumber throughout a building.

In preparing a lumber list, you will sometimes have to figure and list the number of pieces needed of a given length. For example, 450 studs each measuring 92¼ inches in length may be needed for a building. Line 1 in Table 2-8 shows how this may be indicated. Maximum use is made of abbreviations that are standard in the trade. For example, DF stands for Douglas fir and S4S stands for surfaced four sides.

Line 2 in Table 2-8 indicates that 1,500 linear feet of 2 x 4 Douglas fir are needed. If the lumber is for plate stock, it is not necessary to indicate lengths of pieces. Random lengths are satisfactory for plates, and they are cheaper than specified lengths. The grade "Standard and Better" means that Standard grade is the poorest grade that will be accepted. If it is more convenient for the lumber supplier to give the customer a whole unit without having to sort through it, the supplier will do so, and the price will be less. The supplier is usually willing to give the customer some pieces of better-grade lumber to avoid the cost of hand sorting.

Lines 3 and 4 in Table 2-8 are for ceiling joists. Lengths should be specified to ensure that none of

**TABLE 2-7**

Comparative Strengths of Framing Lumber

| Species | Grade | Maximum span of 2 x 6 ceiling joists 16″ o.c. |
|---|---|---|
| Douglas fir | No. 1 | 18′ 5″ |
| Larch | No. 1 | 18′ 5″ |
| Douglas fir | No. 2 | 18′ 1″ |
| Larch | No. 2 | 18′ 1″ |
| Hemlock | No. 1 | 17′ 4″ |
| White fir | No. 1 | 17′ 4″ |
| Hemlock | No. 2 | 16′ 11″ |
| White fir | No. 2 | 16′ 11″ |
| Redwood | No. 1 | 16′ 11″ (not used, but given for comparison of strength) |
| Redwood | No. 2 | 16′ 6″ (not used, but given for comparison of strength) |

**TABLE 2-8**

Lumber Sizes and Descriptions

| Line | Pieces | Size | Length | Description | Board feet |
|---|---|---|---|---|---|
| 1 | 450 | 2 x 4 | 92¼″ | DF Studs S4S | 3,460 |
| 2 | | 2 x 4 | 1,500′ (Linear) | DF Std and Btr | 1,000 |
| 3 | 50 | 2 x 6 | 18′ | DF No. 2 S4S | 900 |
| 4 | 74 | 2 x 6 | 16′ | DF No. 2 S4S | 1,184 |
| 5 | | 1 x 4 | 2,200′ (Lineal) | DF Std and Btr | 733 |

the joists will be too short and that there will be a minimum of waste.

Line 5 is for spaced roof sheathing that is used under shakes. In this case, it is easier to figure the number of board feet needed than to figure either lengths or linear feet. The feet column in Table 2-8 is in board feet. A rule of thumb for figuring the number of board feet of spaced 1 x 4 roof sheathing is to multiply the floor area of the building by 0.75, which allows for waste and the slope of the roof (normally 4 in 12).

Many other rules of thumb are available for estimating lumber, but the subject of estimating is beyond the scope of this unit. As you gain experience in the carpentry trade, you will learn a great deal about making quantity takeoffs (determining and listing materials needed). Many fine courses are offered by trade schools and community colleges in blueprint reading and estimating.

### Study Assignments

1. *Dwelling Construction Under the Uniform Building Code* (1982 edition). Review tables 25-A-1 through 25-U-R-14. Note the header sizes in Fig. 8.
2. Durbahn and Sundberg, *Fundamentals of Carpentry,* Vol. 2, *Practical Construction* (Fifth edition). Reread Chapter 4, "Wall and Floor Framing."

## TOPIC 2 – FRAMING LUMBER

### Study Guide

Determine the correct word for each numbered blank in the sentence, and write it in the corresponding blank at the right.

1. The most widely used framing lumber in the West is 1 2 . — 1. ____ 2. ____

2. When logs are cut at the sawmill, the resulting lumber is in 3 or 4 sizes. — 3. ____ 4. ____

3. The actual size of a surfaced 2 x 4 is 5 inches by 6 inches. — 5. ____ 6. ____

4. The abbreviation "S4S" means 7 8 9 . — 7. ____ 8. ____ 9. ____

5. Strength and appearance determine the 10 of lumber. — 10. ____

6. Each piece of framing lumber is graded by 11 or 12 . — 11. ____ 12. ____

7. Both the terms 13 14 15 and 16 17 18 are needed to use the tables in the *Uniform Building Code* to determine maximum span. — 13. ____ 14. ____ 15. ____ 16. ____ 17. ____ 18. ____

8. The maximum allowable span for a No. 2 DF 2 x 8 ceiling joist on 16-inch centers is 19 . — 19. ____

9. The maximum span for a No. 2 DF 4 x 6 door header is 20 . — 20. ____

10. For post and beam construction carpenters generally use 21 grade lumber. — 21. ____

## ROUGH FRAMING

## TOPIC 3 – HORIZONTAL LAYOUT

This topic is planned to help you answer the following questions:

- **What tools are commonly used for wall layout?**
- **What procedures are followed in laying out walls?**
- **How are door and window openings determined and marked on the layout?**
- **How are corners and partitions marked on the layout?**
- **Why is accuracy in layout of great importance?**

This topic is intended to help you (1) understand the marks on the plates so that you can assemble the walls properly; (2) detect any errors in layout, thereby saving valuable time; and (3) lay out walls, thus advancing your skill in the trade.

### Studying the Building Plans

Before starting any layout job, you should familiarize yourself with the building plans. This will help you form a mental picture of the completed building and avoid making any time-consuming mistakes in layout. You should have all the necessary information so that you can proceed swiftly and accurately with the job.

### Snapping Lines

The first step in horizontal layout is to mark the inside edge of all exterior walls by snapping chalk lines on the subfloor around the perimeter of the building. Measure in 3½ inches (the width of the plate) from the building line at each corner and make a pencil mark. Then, snap a chalk line as accurately as possible between these marks.

Next, mark the locations of all the interior partitions. In doing this, you should work from one end of the building and use a 100-foot steel tape.

After you have marked all partitions from left to right, work from the front to the rear of the building to preclude any accumulation of errors. Also, after you have marked the location of the edge of each partition, snap a chalk line and make large Xs with red Kiel every 2 or 3 feet to indicate the locations of the partitions in relation to the line.

### Cutting Plates

After all of the exterior walls and interior partitions have been located on the subfloor with chalk lines, the top plate and bottom (sole) plate can be cut and tacked down. The bottom plate is tacked to the floor with 8d nails in the location where the wall will later stand. The top plate is tacked to the bottom plate with 8d nails. All of the plates for the building should be cut and tacked down before the studs or openings are laid out.

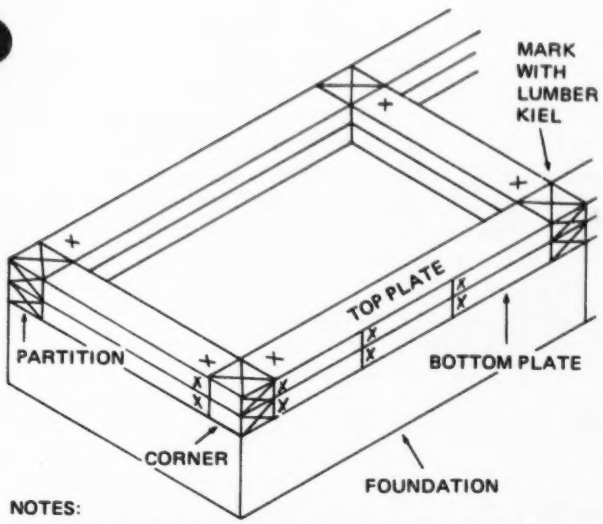
You will have to decide which way to lap the corners because this will later determine the sequence in which you will frame the walls. Ordinarily, the longest walls are framed first and raised into position, and the shorter walls are framed in between.

Plates should be selected from 16- to 20-foot lengths that are as straight as possible. Top plates in particular should be straight, whereas bottom plates may have more curvature. The location of splices is not important in the bottom plates, but top plates must be spliced over a stud or a solid 4 x 12 header. In addition, splices in the top plate must be at least 4 feet from a corner or partition, and joints in double top plates must be staggered at least 4 feet.

### Laying Out the Job

All exterior corners and interior partition intersections should be marked in the manner shown in Fig. 3-1. Use pencil lines to mark the intersections so that you will have accurate marks to work to when nailing the corners together after the framed wall sections are raised into place. Use red Kiel to mark the locations of corner and partition studs (and blocks if they are used).

The next step is to mark all regular studs on the plates with a pencil; mark the exterior walls first, and then the interior partitions. The most common spacing for studs is 16 inches; however, the 1979 *Uniform Building Code* permits stud spacing of 24 inches for single-story houses. Either spacing is acceptable for 4-foot modules that have plywood or other types of sheet materials for exterior sheathing or interior paneling. If the building is to have exterior plywood or other modular sheathing, you should lay out the regular studs to minimize cutting of this material. Stud spacing should be as shown in Fig. 3-2. The center of the first regular stud should be in 16 inches from the outside corner of the building. Since it is customary to mark the edge of the




NOTES:
THE "Xs" INDICATE THE SIDE OF THE LINE ON WHICH THE STUD IS NAILED.
CORNER AND PARTITION LOCATIONS ARE MARKED WITH RED KIEL. ALL OTHER LINES ARE MARKED IN PENCIL.

**Fig. 3-1. Corner and partition markings**

stud, the edge of the first stud should be in 15¼ inches from the corner. To accomplish this quickly, tack a piece of ¾-inch material to the outside corner, with the end of the 100-foot steel tape hooked over this small block. Special markings can be used every 16 inches on the tape to mark the remainder of the studs.

At this stage of the layout, you can ignore door and window openings. You should mark the entire length of the plates with regular 16-inch stud spacing. This practice will pay off later when the ceiling joists and rafters or trusses are installed because the basic layout is there as a reference. Also, the stud bays should be lined up with the overhead joist bays

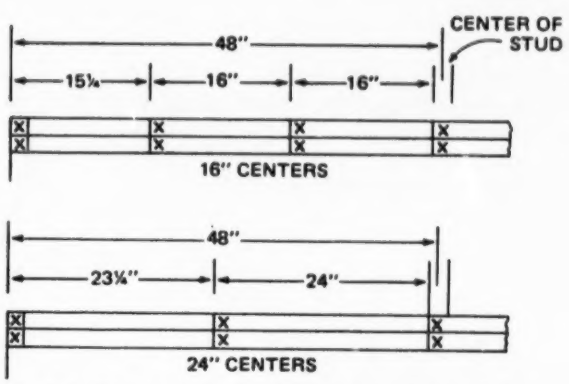



**Fig. 3-2. Standard stud spacing for plywood sheathing**

to simplify installation of plumbing pipes and heating ducts that must go from wall spaces up into the attic or through the roof.

If the studs are to be on 24-inch centers, the above principles apply, but instead of starting the first regular stud in 15¼ inches from the outside corner, start it in 23¼ inches.

You are now ready to lay out window and door openings. Fig. 3-3 shows how a door opening is framed. The width of the rough opening depends on the type of door. For most doors the rough opening is 2½ inches wider than the actual door size. This allows 1½ inches for the door jambs and ½-inch clearance for shimming on each side of the jamb. Two exceptions are (1) pocket doors, for which the door size must be doubled before the 2½ inches is added; and (2) sliding bypass doors, such as sliding wardrobe doors, for which 1 inch must be subtracted for the overlap of the two doors. Thus, for bypass doors, 1½ inches has to be added to the sum of the widths of the two doors to obtain the rough opening. Table 3-1 contains a summary of the rough openings for some typical doors.

The procedure for laying out a door opening on the plates is as follows: Locate the center of the opening from the plans. Next, figure the rough

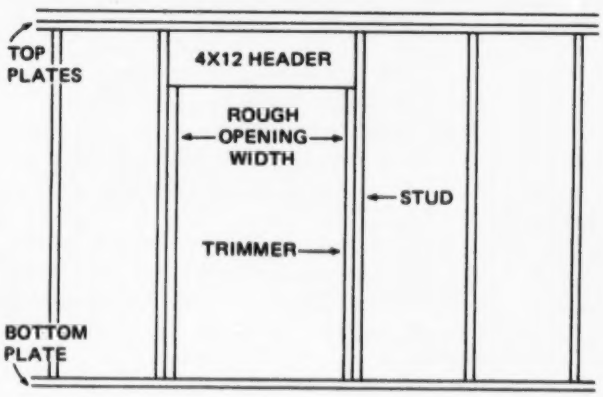



**Fig. 3-3. Rough opening for door**

opening and center it on the centerline of the door opening. As shown in Fig. 3-4, the locations of the door trimmer and the stud are marked with the letters T and X, respectively. For accuracy, use a pencil to mark the line and a piece of Kiel to make the letters T and X more visible. Kiel should be used to write the header length on both the top and bottom plates near the center of the opening. Also, you should draw a Kiel line through the regular stud layout markings to the location of the pencil line at the letter X.

The procedure for laying out windows is similar to that used for doors. However, it is complicated somewhat by the fact that window sizes differ from one manufacturer to another manufacturer; therefore, no single rule applies for window openings. For example, a 6040 window (6 feet wide by 4 feet high) made by one company may have a rough opening width of 73 inches, while a similar window made by another manufacturer may have a rough opening width of 71½ inches. Therefore, before laying out windows, and particularly before ordering precut headers, you should contact the window supplier to find out the exact dimensions of the rough openings. This will preclude the necessity for costly remodeling before the building is even completed.

After you have laid out the plates for the window, write the nominal window size on the subfloor with Kiel. This number tells which package of precut materials to use. Window sills and cripples can be cut on the job without having to refer to the plans.

The procedure for laying out patio doors is the same as that for windows with a few minor exceptions. Like windows, sliding patio doors vary in size depending on the brand, and so the rough openings must be obtained from the supplier. The plates are marked in the same manner as the windows, and the patio door size is written on the subfloor with Kiel.

Sometimes it is necessary when framing to furr down the height of the opening for certain brands of patio doors. If this is the case, clearly mark the height of the opening on the subfloor with Kiel.

TABLE 3-1

Rough Openings for Typical Doors

| Door width | Door type | Rough opening (width) | Header length |
|---|---|---|---|
| 3′ | Swinging | 38½″ | 41½″ |
| 6′ | Bifold | 74½″ | 77½″ |
| 3′ | Pocket | 74½″ | 77½″ |
| 8′ | Sliding bypass | 97½″ | 100½″ |

In all layout work it is essential to work accurately so that the building is plumb and square and has parallel walls. It is much cheaper to spend a few extra minutes thinking or using pencil and Kiel than to spend hours with a wrecking bar and a catspaw tearing apart an incorrectly laid out door or window opening or incorrectly located partition. Gross errors in layout are usually detected during framing and can be corrected. But smaller errors may not show up until kitchen cabinets or other casework is being installed. At this point it is usually not practical to tear out incorrect framing; therefore, some unsightly compromise must be made to hide mistakes that resulted from walls that are out of plumb or rooms that are not square.

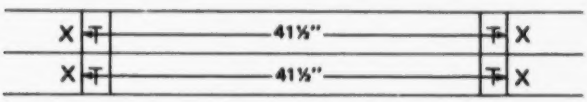



Fig. 3-4. Door layout

### Study Assignments

1. Durbahn and Sundberg, *Fundamentals of Carpentry,* Vol. 2, *Practical Construction* (Fifth edition). Review Chapter 4, "Wall and Floor Framing."
2. *California Contemporary House Plans.* Lay out plates selected by the instructor in a suitable open area.

## TOPIC 3 – HORIZONTAL LAYOUT

### Study Guide

Determine the correct word for each numbered blank in the sentence, and write it in the corresponding blank at the right.

1. Studying the plans will help you form a __1__ __2__ of the building before it is constructed. — 1. _____ 2. _____

2. The first step in layout is to snap __3__ __4__ on the subfloor around the perimeter of the building to mark the __5__ edge of each exterior wall. — 3. _____ 4. _____ 5. _____

3. The locations of interior partitions are determined by measuring from one __6__ of the building to avoid an accumulation of __7__ . — 6. _____ 7. _____

4. When snapping lines to locate partitions, you should mark the __8__ of the partition. — 8. _____

5. Carpenters have to decide which way to lap the __9__ because this determines the __10__ in which they will later frame the walls. — 9. _____ 10. _____

6. All of the plates for the building should be __11__ and __12__ down before layout of the studs or __13__ begins. — 11. _____ 12. _____ 13. _____

7. The most common spacing for studs is __14__ , but the *Uniform Building Code* permits studs to be spaced as far apart as __15__ . — 14. _____ 15. _____

8. If the building is to have exterior plywood or other __16__ __17__ , you should lay out the regular studs to minimize __18__ . — 16. _____ 17. _____ 18. _____

9. If possible, you should line up __19__ bays with __20__ bays. — 19. _____ 20. _____

10. For most types of doors, the rough opening is __21__ wider than the door. — 21. _____

## ROUGH FRAMING

## TOPIC 4 – VERTICAL LAYOUT

This topic is planned to help you answer the following questions:

- **How are the lengths of studs, trimmers, and cripples determined?**
- **How is the height of headers determined?**
- **How is the height of rough sills determined?**
- **How is a story pole made and used?**

Before starting vertical layout, you should carefully study the plans to avoid costly errors. Examine the "door and window schedules," which list the type and size of all windows and doors in the building. In some cases the schedules give the name of the window and patio door manufacturer, but in other instances you may have to refer to the specifications for this information. The previous topic indicated that the rough openings for windows and patio doors are not consistent from one brand to another brand. To obtain the rough openings, you should contact the manufacturer's representative or the supplier in your area.

### Stud Length

In conventional residential framing the standard height of walls—subfloor to ceiling joist—is 8′ ¾″. To determine the stud length, subtract the combined thicknesses of the bottom plate and the two top plates from this figure, thereby obtaining a standard stud length of 92¼ inches.

8′ ¾″ = 96¾″ wall height
− 4½″ (3 X 1½″) combined thickness of bottom and two top plates
92¼″ Stud length

The same method is used for other buildings of different heights, provided there is one bottom and two top plates; subtract 4½ inches from the wall height to obtain the stud length.

### Trimmer Length

Two methods for framing doors are shown in Fig. 4-1. The most common method is to use a 4 x

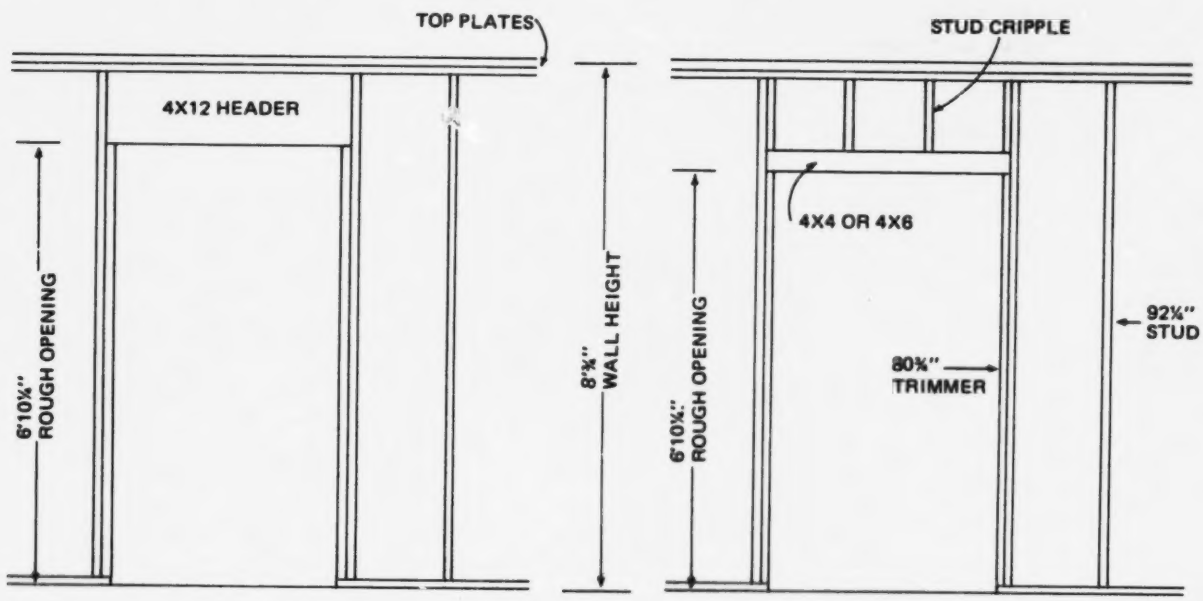



**Fig. 4-1. Methods for framing doors**

12 header, even though a smaller header is capable of carrying the load. The increase in lumber cost is less than the cost of labor for cutting and nailing the short cripple studs above the smaller header.

The correct rough opening height (6′ 10¼″) for most doors, including swinging, bifold, sliding or bypass, and accordian, is obtained by using a 4 x 12 header. An important exception to this rule is the pocket door. Because of the track that is screwed to the head jamb, there is a greater thickness above the door. The rough opening height must be 2 inches greater, or 7′ ¼″; therefore, a 4 x 10 header is used for pocket doors.

If a 4 x 12 header is used, the trimmer length is as follows:

| | |
|---|---|
| 92¼″ | stud length |
| −11½″ | height of 4 x 12 header |
| 80¾″ | trimmer length (except pocket doors) |

For a pocket door the trimmer must be 2 inches longer, or 82¾ inches.

When smaller headers are used, the trimmer lengths are the same because the rough opening heights are the same. However, cripple studs are installed above the header. The length of the cripple studs will vary, depending on the header size (Table 4-1). Cripple studs that are 2 inches or shorter should not be used; they will split. Horizontal blocking consisting of 2 x 4s and ½-inch plywood should be used to make up the 2-inch spacing.

The rough opening heights discussed before are acceptable, provided the bottom of the finished door is at least 1¼ inches above the subfloor. If the finish floor is to be very thin, and you want to reduce the crack below the door, you will have to furr down the header accordingly. When the entire door unit is lowered, the height of the rough opening must be reduced so that the head casing will cover the joint between the head jamb and the wall finish above the door after the door has been trimmed out.

### Sliding Patio Doors

Sliding patio doors are normally framed with 4 x 12 headers in the same manner as standard doors. Some brands of patio doors are smaller than other brands, and it may be necessary to furr down the opening. Check with the supplier so that you can frame the opening to the correct size.

### Window Trimmers and Cripples

In conventional framing most windows are framed with 4 x 12 headers so that the height of the rough opening is the same as that for standard doors. Therefore, the trimmer length is also 80¾ inches. The height of the rough sill off the subfloor depends on the size and brand of the window. The correct rough opening sizes can be obtained from the window supplier. Table 4-2 gives the rough openings for one brand of windows.

**TABLE 4-1**

Cripple Stud Lengths

| Standard doors | Cripple stud length | Pocket door | Cripple stud length |
|---|---|---|---|
| 4 x 4 header | 8″ | (4 x 4 header too small for load) | |
| 4 x 6 header | 6″ | 4 x 6 header | 4″ |
| 4 x 8 header | 4″ | 4 x 8 header | 2″ (blocking) |
| 4 x 10 header | 2″ (blocking) | 4 x 10 header | none |

**TABLE 4-2**

Rough Opening for One Brand of Windows

| Heights | Widths | | | | | |
|---|---|---|---|---|---|---|
| | 25″ | 37″ | 49″ | 61″ | 73″ | 97″ |
| 24½″ | 2020 | 3020 | 4020 | 5020 | 6020 | 8020 |
| 36½″ | 2030 | 3030 | 4030 | 5030 | 6030 | 8030 |
| 48½″ | 2040 | 3040 | 4040 | 5040 | 6040 | 8040 |
| 60½″ | 2050 | 3050 | 4050 | 5050 | 6050 | 8050 |

Table 4-2 indicates that the rough opening height for a 6040 window must be 48½ inches. The basic framework of this 4-foot-high and 6-foot-wide window is shown in Fig. 4-2. Because the

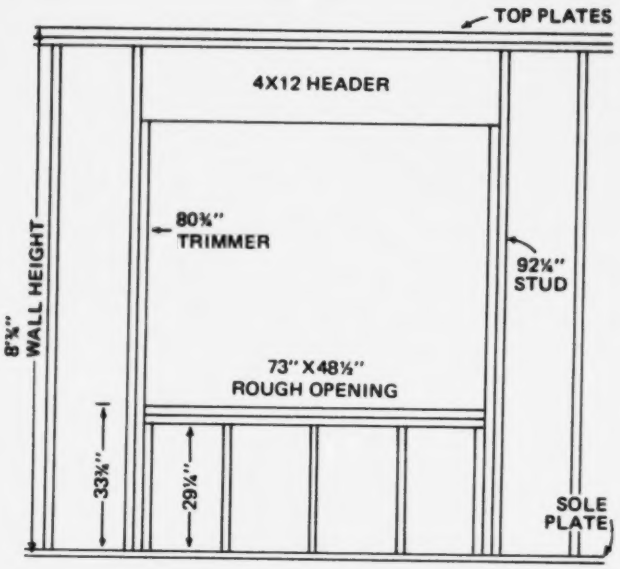



**Fig. 4-2. Window framing**

window is more than 4 feet in width, the sill must be doubled for strength. The height of the rough sill off the subfloor is calculated as follows:

| | |
|---|---|
| 80¾" | trimmer length |
| + 1½" | bottom plate thickness |
| 82¼" | height of header above subfloor |
| −48½" | height of rough opening |
| 33¾" | height of rough sill above subfloor |

To find the length of the cripple stud, subtract 4½ inches from 33¾ inches, as follows:

| | |
|---|---|
| 33¾" | height of rough sill above subfloor |
| − 4½" | combined thicknesses of two rough sills and sole plate |
| 29¼" | cripple length |

Thus, for this particular size and brand of window, the length of the cripple stud is 29¼ inches. This cripple stud length will be used for all windows that have a nominal rough opening height of 4 feet and a double sill. For windows 4 feet or narrower, you only have to use one rough sill. The cripple studs for these windows will be 1½ inches longer, or 30¾ inches.

## Story Pole

A story pole can be extremely valuable in laying out certain split-level buildings or structures with varying window heights. This measuring device is usually made of a 1 x 2 or 1 x 4 strip of wood. The pole is laid out to indicate the exact position of each member of the frame, with the heights of members such as the floor or ceiling joists, top plates, and rough window sills (Fig. 4-3) on one side and the lengths or widths of members such as headers, doors, and windows on the other side. Large tracts of homes having many identical floor plans can be laid out by one carpenter with one set of "rods" that show the position of all horizontal and vertical structural members.

The story pole can be used to preclude costly errors in construction. However, in conventional buildings, such as those previously discussed, using a story pole is generally considered to be a waste of time. In these cases, you can readily figure the stud and trimmer lengths, the heights of header and window sills, and the lengths of the cripple studs.

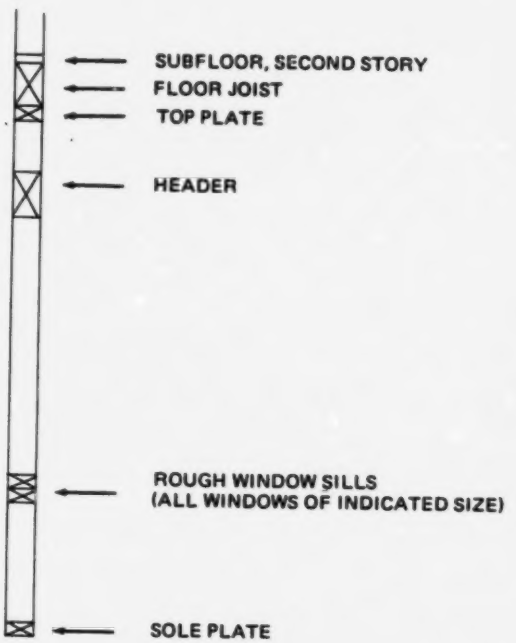



**Fig. 4-3. Story pole**

## Sloping Walls

As a carpenter you can use a number of "tricks" that are helpful in laying out a building that has sloping walls (Fig. 4-4). Each stud in the wall in the

illustration is of a different length, and the top of each stud is beveled. To lay out this wall, use the following procedure:

1. Snap a chalk line on the subfloor between points 1 and 2 to indicate the bottom of the wall as it would appear if it were lying on the floor.
2. Snap a line between points 1 and 3 to indicate the shortest wall.
3. Snap a line between points 2 and 4 to indicate the tallest wall.
4. Snap a line between points 3 and 4 to indicate the top of the wall.
5. Snap a line between points 5 and 6 to indicate the underside of the top plates; studs will extend to this line
6. Lay out the studs on the line between points 1 and 2.
7. Stretch a steel tape from point 5 to point 7 and lay out the studs on the subfloor.
8. Snap a vertical line along the edge of each stud.

After completing the above procedure, you should have a picture of the wall in chalk on the subfloor. You only have to cut plates and studs to match the chalk lines, and the wall is completed.

If windows or doors are to be put in a sloping wall, it is easier to locate them after snapping the lines for the regular studs. Then, snap lines to indicate the location of the rough sill, header, and trimmers. A story pole may be helpful in laying out the sills and headers.

When the slope of the wall conforms to the slope of the roof, a steel square can be used to determine the difference in stud lengths. This is done by establishing a reference line using the unit of rise and the unit of run. The blade of the square is slid along the reference line to the stud spacing, and the difference in length is read on the tongue.

### Study Assignments

1. Durbahn and Sundberg, *Fundamentals of Carpentry,* Vol. 2, *Practical Construction* (Fifth edition). Review chapter 4, "Wall and Floor Framing."
2. *California Contemporary House Plans.* Select a wall from the plans and make a full-size layout, showing the location of fire blocking, window rough sill, door header height, and top plates.

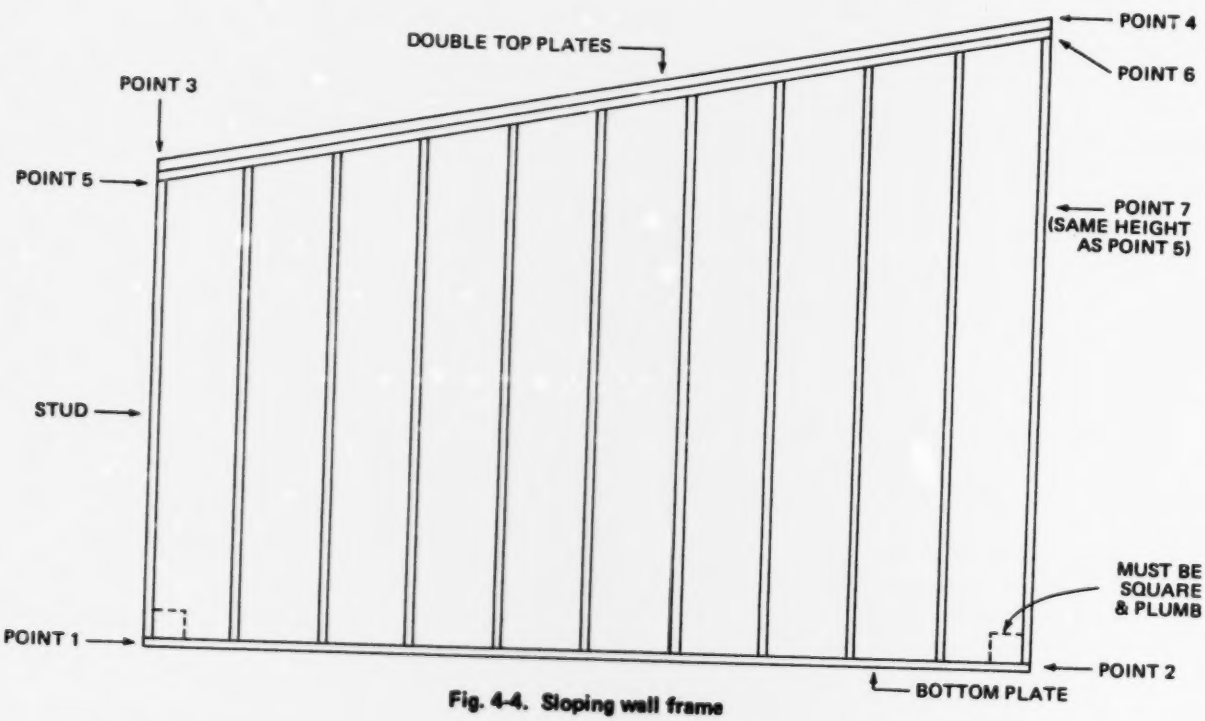



**Fig. 4-4. Sloping wall frame**

## TOPIC 4 – VERTICAL LAYOUT

### Study Guide

Determine the correct word for each numbered blank in the sentence, and write it in the corresponding blank at the right.

1. Door and window schedules are __1__ that give the __2__ and __3__ of all windows and doors in the building. — 1. _____ 2. _____ 3. _____

2. Rough openings for __4__ and __5__ __6__ sometimes differ from brand to brand. — 4. _____ 5. _____ 6. _____

3. In conventional residential framing the standard height of walls is __7__. — 7. _____

4. The standard stud length is __8__. — 8. _____

5. The most common size header for __9__ and __10__ is a 4 x 12. — 9. _____ 10. _____

6. When a 4 x 12 header is used, the trimmer length is __11__. — 11. _____

7. The rough opening height for a pocket door must be __12__ inches more than that for other standard doors, which gives a trimmer length of __13__. — 12. _____ 13. _____

8. When smaller headers are used, you must cut and nail in short __14__ __15__ to fill the space between the header and top __16__. — 14. _____ 15. _____ 16. _____

9. A story pole is generally a __17__ of __18__ unless the design of the building is different enough to warrant it. — 17. _____ 18. _____

10. A story pole can be extremely valuable in laying out certain __19__ and __20__ buildings. — 19. _____ 20. _____

## ROUGH FRAMING

## TOPIC 5 — ERECTING FRAMED WALLS

This topic is planned to help you answer the following questions:

- **What sequence is followed in nailing the various parts of the wall together?**
- **What nail sizes and spacing are required by the *Uniform Building Code?***
- **What kinds of wall bracing are used, and how are they installed?**
- **How is a building plumbed and aligned?**
- **How are wood and steel framing members combined for certain purposes?**
- **What safety procedures must be followed in erecting walls?**

The easiest and fastest way to frame walls is to nail all of the various parts together on the subfloor. As each section of wall is completed, it is raised into place and temporarily braced.

### Framing Sequence

You must consider carefully the best sequence in which to frame the various wall sections. Ordinarily, the longer exterior walls are framed before the shorter exterior walls are framed. This procedure allows the walls to be raised directly into position and avoids having to slide or drag them to the place where they will stand permanently.

After all of the exterior walls have been raised into position, nail the corner studs to one another with six 16d nails spaced as follows: two near the bottom; two near the midpoint; and two near the top. The nails should be staggered as shown in Fig. 5-1. In addition, the double top plates should be nailed with two 16d nails where they lap at each corner.

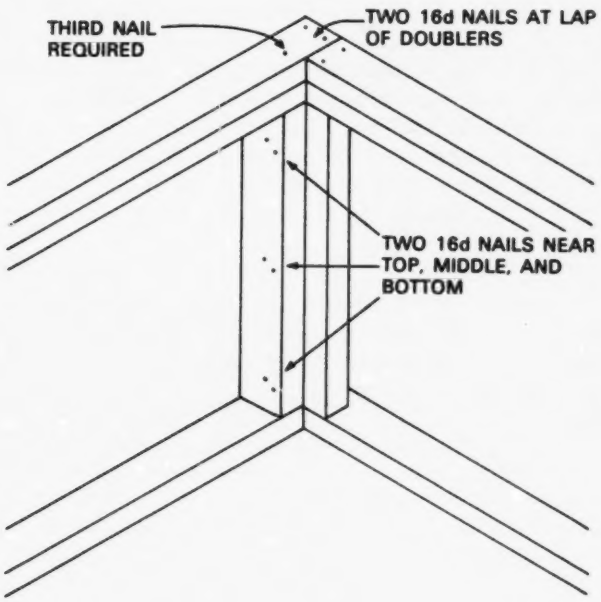



**Fig. 5-1. Corner nailing requirements**

The interior partitions are framed in the same manner as the exterior wall sections. After each wall section is nailed together, it is raised into place. Use only as many temporary braces as are necessary for safety to keep the partitions from falling over. Interior partitions do not need many braces, because they are nailed to the outside walls, which are braced. By using as few braces as is necessary for safety, you can minimize cluttering the working space.

#### Top and Bottom Plates

To frame the wall, first separate the top and bottom plates from where they are tacked together on the subfloor. The bottom plate should be set on edge near the chalk line where it will be permanently installed. The top plate should be placed on edge slightly more than a stud's length away from the bottom plate (Fig. 5-2). Make sure that the layout markings on both plates are up and visible.

The studs are placed at each position specified by the letter X on the layout. In addition, the door and window headers are placed where they will be nailed into the frame. The top and bottom plates are then nailed to the studs with two 16d nails at the end of each stud.

Corners and partitions are usually framed with three studs, as shown in Fig. 5-3. The most expedient method for framing a corner is shown in View A of Fig. 5-3, while the best method for assembling a partition corner is shown in View C of Fig. 5-3. These methods offer significant savings in labor costs that offset a slight increase in materials costs.

When framing components are installed near door or window openings, the top plate is nailed to a header with 16d nails staggered on 24-inch centers.

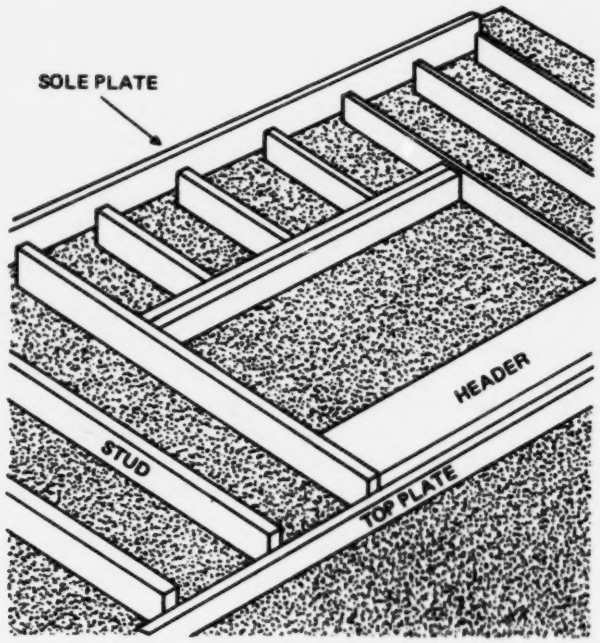



Fig. 5-2. Nailing wall parts together

Also, a king stud is nailed to each end of the header with five 16d nails through the stud into the end of the header (Fig. 5-4). After the king studs and headers are nailed, the trimmers are nailed in place with 16d nails on 24-inch centers. Sometimes two 8d toenails are required to fasten the tops of the trimmers to the header.

#### Window Openings

For assembling window openings, nail the cripple studs in place, and then nail the rough sill in place. Two 16d nails should be used through the plate into the bottom of the cripple stud, and two 16d nails should be used through the sill into the top of the cripple stud. Toenail the end of the sill to the trimmer with two 8d nails at the top and at the bottom if the cripple stud against the trimmer is omitted. If the window is more than 4 feet in width, double the sill. In this case, the top sill should be nailed to the bottom sill using one 16d nail on 16-inch centers (over each cripple stud), and the ends should be toenailed to the trimmer.

After all studs, headers, trimmers, window sills, and cripple studs have been nailed in place, any required stud bridging should be installed with two 16d nails at one end and with one 16d nail at the other end. Stud bridging is not required in single-story homes that have standard 8′ ¼″ high walls. Some builders use stud bridging near corners and openings to stiffen the walls. Stud bridging is required at exterior walls and interior bearing partitions on lower floors of multistory buildings. It is also required for boxed cornices and at stairs.

You should install the double top plates while the wall is down on the subfloor because it takes considerably longer to install them after the walls have been raised into position. However, in some cases, where the doublers protrude beyond the end stud, they must be left off until after the wall is raised into position. Usually this is not necessary; the walls can be leaned outward to make room to raise the wall in question.

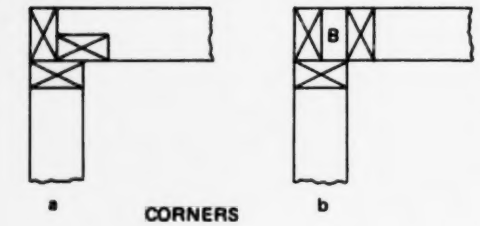
#### Bracing

Next, install the diagonal 1 x 4 or 1 x 6 let-in braces. These braces are required at each end of exterior walls and main interior partitions and every 25 feet in long walls. Diagonal braces give the greatest lateral resistance if they are at a 45-degree angle. However, it is not always possible to do this because of openings. These braces can be as steep as 60 degrees (five stud bays, or 80 inches horizontal). When framing the wall on the subfloor, you should not nail the braces up tight, but should just start the nails. The nails will be driven home when the building is being plumbed and aligned. The required nailing is two 8d nails at each stud and three 8d nails at each plate. When installing let-in bracing, make certain that the wall is square before notching the studs. If the wall is out of square, the notches will be in the wrong location when the building is plumb, and the braces cannot be nailed. Also, when marking and cutting the notches, you must work accurately so that the brace fits snugly into the notch. Sloppy cutting of these notches may result in the building inspector's turning down the building when he or she inspects the framing.

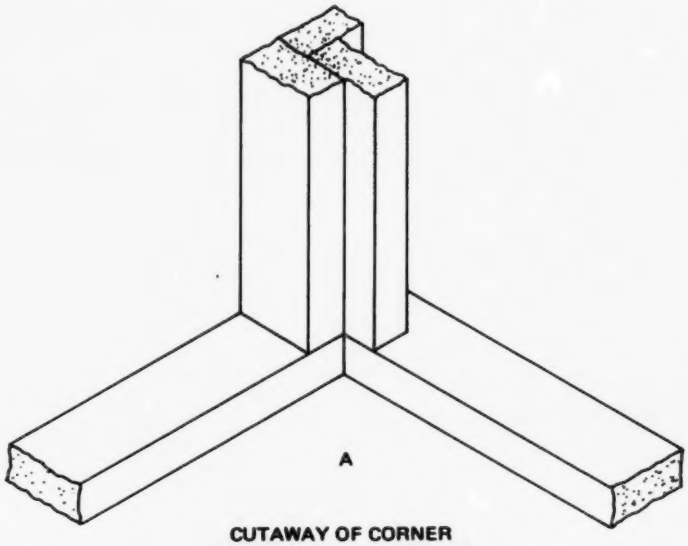
#### Wall Sheathing

If plywood wall sheathing with approved nailing is used, let-in bracing can be omitted in exterior walls. For single-story houses the sheathing must be at least $^{5}/_{16}$-inch thick and should be CDX (16/0) grade or better. Minimum nailing is 6d nails spaced 6 inches on centers at plywood edges and 12 inches on centers along each intermediate stud. This is called "in the field." Staples are often used instead of nails. For $^{5}/_{16}$-inch sheathing, the staples must be at least 1¼-inches long and be spaced 4 inches at edges and 8 inches in the field.

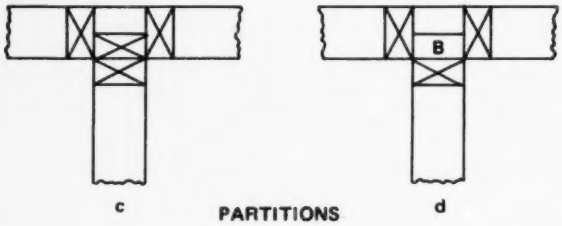
Plywood wall sheathing can be installed while the wall is still lying on the subfloor. If this method

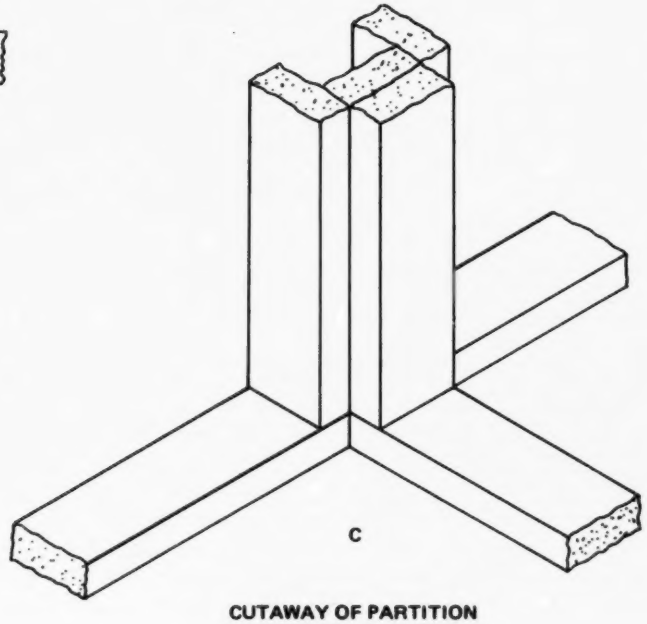



X = STUD
B = 3 SPACED BLOCKS




CUTAWAY OF CORNER
SHOWING STUD ASSEMBLY




CUTAWAY OF PARTITION
SHOWING STUD ASSEMBLY

**Fig. 5-3. Framing methods for corners and partitions**

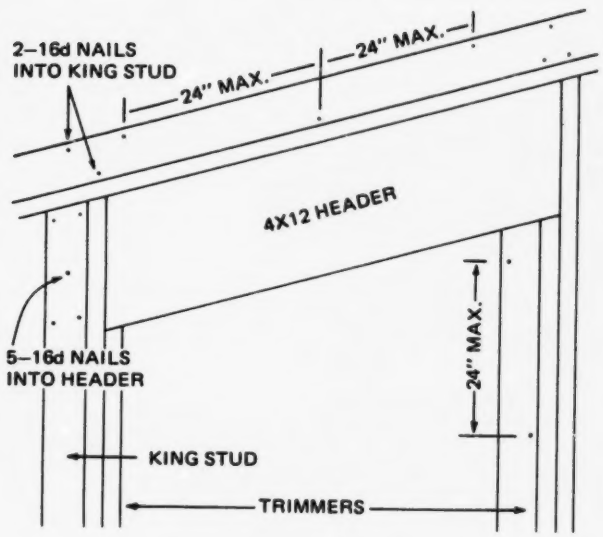



**Fig. 5-4. King stud and header nailing configuration**

is used, make sure that the walls are perfectly square before nailing the sheathing. It is quicker to install sheathing while the walls are still down, but some builders prefer to do it after the walls are up and are plumbed and aligned. They feel that this provides greater accuracy in plumbing the corners, since any irregularities in the floor may cause the corners of presheathed walls to be slightly out of plumb. If care has been taken during construction of the floor system, this problem should not occur. When plywood sheathing is installed, space must be left around each sheet for expansion from moisture absorption. Also, a $^1/_{16}$-inch space should be left between the ends, and a $^1/_8$-inch space should be left between the edges of the sheets. If space is not left at these locations, buckling may occur during damp weather.

### Erection of Wall Frames

After the wall is completely framed on the subfloor, it is ready to be raised into its permanent location. Walls are heavy, and to avoid injuries, the supervisor should have one helper for every 10 feet of wall to be lifted. Additional help will be needed if the plywood sheathing has been installed. To keep exterior walls from slipping off the subfloor, nail 2 x 4 cleats along the outside edge of the subfloor. These cleats should be firmly nailed with at least three 16d nails and should be spaced no more than 15 feet apart. This precaution is particularly important when working on upper stories or on high hillside buildings.

As the exterior walls are raised into position, they must be temporarily braced. A level is not needed at this point. In fact, it is more convenient if the first walls are leaned outward slightly—approximately 3 inches. This makes it easier to get subsequent walls up with the doublers in place. Temporary bracing must be adequate to prevent the walls from falling down, from being blown down, or from being knocked down accidentally by workers or by children who might be at the site after working hours. For details on bracing, see the *Construction Safety Orders.*

Occasionally when a wall is being lifted, it comes apart and causes injury to the workers. This can be avoided by making certain that the wall is nailed correctly, particularly headers and doublers, and that the wall is lifted fairly evenly. Workers are in more danger when they lift the top-heavy walls of tall buildings. Sufficient help should be available to make sure that no one is injured during this operation.

Before beginning to plumb and align the walls, make sure that all corners are completely nailed, including the laps in the doublers. Also, the bottom plates of all walls should be nailed down with 16d nails on 16-inch centers. This is accomplished by placing one nail in each bay near a stud. These nails should be staggered—one near the inside, another near the outside of the bottom plate, and so forth. Before driving the nails, make sure that the bottom plate is aligned with the chalk line located on the side of the wall and that the plate is on the correct side of the line.

### Plumbing and Alignment

All of the exterior corners must be plumbed in both directions. To do this, select a stud that is basically straight and make a straightedge (Fig. 5-5). The reason for using the straightedge rather than a carpenter's level is that studs are frequently bowed. You would get a different reading with the level on a crooked stud, depending on where you placed it. With blocks at the top and bottom of the straightedge, any curvature in the corner studs will not affect the reading of the level.

Plumbing and aligning is done most efficiently by two carpenters working together. As one uses the straightedge to check for plumb, the other one racks the wall until it is plumb and then nails the diagonal let-in bracing. Temporary diagonal bracing must be nailed to the interior surfaces of walls that do not have let-in bracing because of large openings or other reasons.

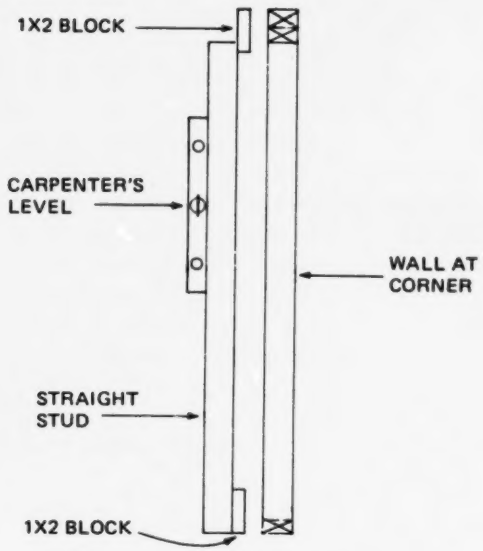



**Fig. 5-5. Carpenter's straightedge**

After the outside corners have been plumbed, and all diagonal bracing has been nailed to the exterior walls, the outside walls are then aligned. Blocks—usually pieces of 1 x 2—should be nailed to the outside of the top plate at each corner. Stretch a string tightly over the blocks, and use a piece of material (same thickness as the blocks) as a gage under the line to determine whether the wall is straight. Do this every 4 to 6 feet. Temporary bracing should be used as needed to keep the wall straight. Patented metal braces that are convenient to use can be obtained for this purpose. They have a screw arrangement that allows the wall to be pushed out or pulled in with the brace. If metal braces are not available, 2 x 4 or 2 x 6 wood braces can be used. After all exterior walls are plumbed and aligned, plumb the interior corners, and nail all of the remaining let-in braces. Then, align the interior walls with a string in the same manner as the exterior walls. If the walls are short, they can be sighted for straightness. Temporary braces should be used as needed.

After all corners have been plumbed and all walls aligned, install the ceiling joists. Ceiling joists or trusses should never be installed before the building has been plumbed and aligned. If they are nailed in place, you will not be able to rack or bend the walls to make them true and plumb. All temporary bracing on walls must remain in place until after the roof framing has been completed and all roof and wall sheathing has been installed and correctly nailed. Only then is the building sufficiently rigid to withstand the wind and seismic loads for which it was designed.

### Combined Wood and Steel Framing Members

Sometimes it is necessary to use steel columns or beams as framing members because wood is not strong enough for the design loads. Steel columns can also be installed in a way that gives lateral bracing to the building. An example of this is a column base that has been sunk into a concrete pier (Fig. 5-6). Pipe columns, sometimes called "lally columns," are often used in free-standing carports or in apartment houses where the living area is over a partially open carport.

Hollow pipe columns are sometimes filled with concrete grout, which is concrete made with pea gravel and enough water to make it run freely. The grout mixture must be rich in cement—usually seven sacks per cubic yard—to offset the loss in strength caused by the relatively high water content of the mixture.

Steel beams are sometimes used to support wooden joists, as shown in Fig. 5-7. The method shown in View A of Fig. 5-7 is essentially no different from that used with wooden beams or girders. The only difference is that a wood plate is bolted to the steel beam for nailing. The required nailing is three 8d toenails from each joist into the woodplate

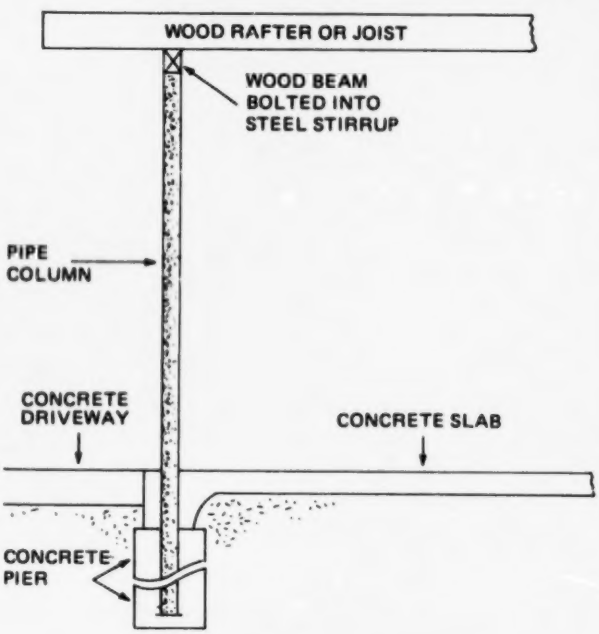



**Fig. 5-6. Carport pipe column**

and three 16d nails through one joist into the other joist to prevent the building from spreading at this point.

The method shown in View B of Fig. 5-7 reduces the height needed by the joist and beam system. A steel plate is bolted to the underside of the steel beam to give added support to the joist. Clearance must be left above the steel beam to allow for shrinkage of the wood. A 2 x 12 or 2 x 10 joist may shrink as much as ¼ to ⅜ inch if the lumber is green when it is installed. Allowances must be made for shrinkage whenever wood is combined with steel or masonry to avoid splitting, to keep the floor level after the wood shrinks, and to keep the wood from pulling loose from the steel or masonry.

**Study Assignments**

1. *CAL/OSHA, State of California Construction Safety Orders* (1979 edition). Los Angeles: Building News, Inc. Read articles 3, 19, 29, and 34.
2. Durbahn and Sundberg, *Fundamentals of Carpentry*, Vol. 2, *Practical Construction* (Fifth edition). Reread Chapter 4, "Wall and Floor Framing."
3. *Dwelling Construction Under the Uniform Building Code* (1982 edition). Review tables 25-Q, 25-M, and 47-J, and Figs. 6 and 9 showing balloon and platform framing.
4. *California Contemporary House Plans.* Select walls from the floor plan and determine the sequence of assembly and erection of the walls.

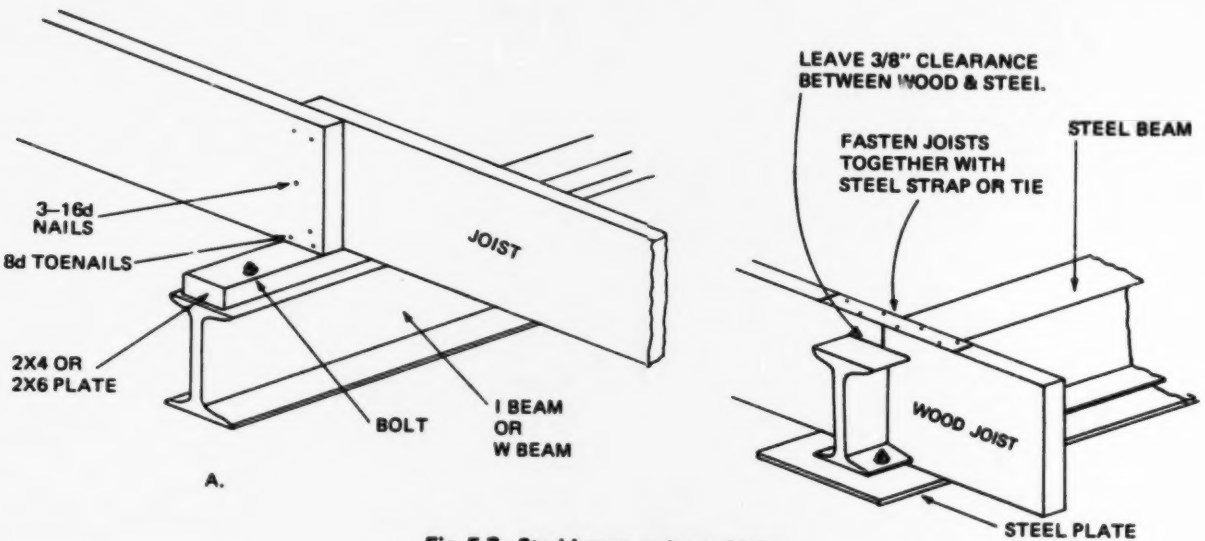



**Fig. 5-7. Steel beams and wood joists**

## TOPIC 5 – ERECTING FRAMED WALLS

### Study Guide

Determine the correct word for each numbered blank in the sentence, and write it in the corresponding blank at the right.

1. The _1_ and _2_ way to frame walls is to nail _3_ the various parts together on the subfloor. — 1. _____ 2. _____ 3. _____

2. Ordinarily carpenters frame the _4_ _5_ walls first. — 4. _____ 5. _____

3. When preparing to frame a wall, you should place the bottom and top plates on the floor with the _6_ up. — 6. _____

4. Corners and _7_ are framed using _8_ studs. — 7. _____ 8. _____

5. A king stud should be nailed to a 4 x 12 _9_ with _10_ 16d nails. — 9. _____ 10. _____

6. If a window is more than _11_ in width, a _12_ sill must be used. — 11. _____ 12. _____

7. Let-in bracing is required at _13_ end of exterior walls and _14_ interior partitions. — 13. _____ 14. _____

8. Let-in bracing can be omitted at exterior walls if _15_ _16_ _17_ is used. — 15. _____ 16. _____ 17. _____

9. To help prevent injury during lifting of walls, the supervisor should have one worker for every _18_ feet of wall. — 18. _____

10. Before you begin plumbing and _19_, you should make sure that all _20_ and _21_ are completely nailed. — 19. _____ 20. _____ 21. _____

## TOPIC 6 – CEILING JOISTS

This topic is planned to help you answer the following questions:

- **What factors should be considered in laying out ceiling joists?**
- **How are ceiling joists cut?**
- **How are ceiling joists installed, and what are the nailing requirements?**
- **What is the purpose of backing, and how is it installed?**
- **How is the proper size of ceiling joists determined?**
- **How do ceiling joists strengthen a building?**

### Lay Out of Joists

Although it is not always possible, try to locate the ceiling joists directly over the studs. The main advantage of having the joist bays over the stud bays is that it makes it easier to install plumbing pipes and heating ducts or flues that must pass from the wall up into the attic or that must go through the roof. Also, the building is somewhat stronger when the joists are installed directly or nearly over studs. However, if the building has double top plates, the building codes do not require this type of alignment.

If the studs are laid out on 16-inch centers with a steel tape, you can generally use that layout again by merely positioning each joist over the stud below. Ceiling joists usually are not long enough to span across the entire building; therefore, they must be lapped, as illustrated in Fig. 6-1. In this kind of layout, the joists on the side of the building may be offset 1½ inches from those on the other side. Such a small offset is quite acceptable and generally causes no problem with heating or plumbing. However, some builders take this into account and lay out studs so that all studs at outside walls are directly under the joists.

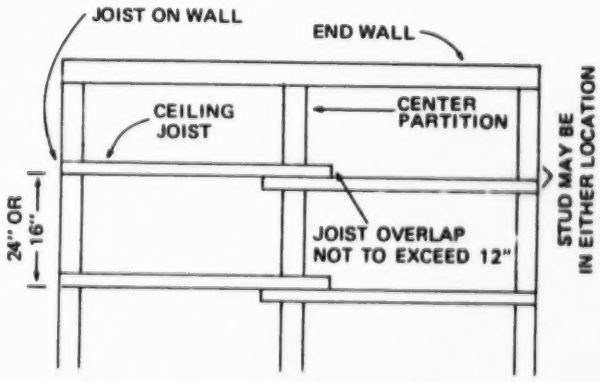



**Fig. 6-1. Plan view of typical joist layout**

If possible, ceiling joists should run parallel to the rafters, which are commonly placed on 24-inch centers. In cases where the ceiling joists are also on 24-inch centers, each of the ceiling joists can be nailed to a rafter at the outside plate. On the other hand, if the ceiling joists are on 16-inch centers, which is the most common spacing in ceiling framing, every other rafter will be nailed to a ceiling joist. Nailing ceiling joists to rafters provides an important tie across the building; it keeps the structure from spreading because of roof loading. The required nailing is three 16d nails through the rafter into the joists.

Sometimes buildings are designed so that the joists do not run parallel to the rafters. In these cases, it is necessary to provide 2 x 4 ties that are parallel to the rafters–perpendicular to joists–across the entire building. These ties keep the building from spreading. They may not be spaced more than 4 feet apart. The ties are nailed into the top of each joist with two 16d nails and into the rafters or blocking at the outside of the building with three 16d nails.

### Cutting of Joists

To prepare a ceiling joist for installation, first cut (nub) off one end, as illustrated in Fig. 6-2, so that the joist end will not protrude above the roof line. The side of the joist that is crowned must be nubbed so that the crown is up when the joist is installed. If the crown were down, the ceiling would sag, and the sag would get worse with time. With the crown up, any sagging tends to straighten the ceiling. In most cases, it is not necessary to cut the joists to length. After the joists are installed, they can be trimmed in place so that they extend no more than 2 to 3 inches beyond the center bearing partition. You can do this quickly with a portable power saw that has the blade set for a depth of cut of 1½ inches.

In a large room where the ceiling joists do not span across the entire room, they must be supported

at midspan by a beam. In this case, the joists must be cut to length so that the ends do not protrude beyond the outside of the building. The joists are

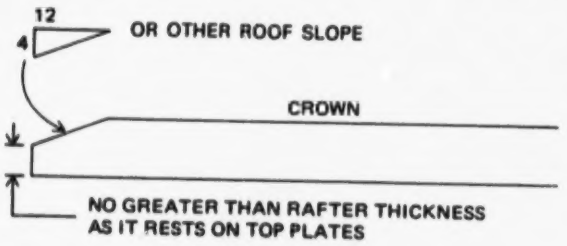



**Fig. 6-2. Nubbed ceiling joist**

supported at the beam by metal joist hangers. The beam can also be placed above the joists, and the joists can be hung from the beam by straps. This construction practice is seldom used, but you should keep it in mind for use on a rare occasion when it may be the best solution to a design problem. In those cases where joists must be cut to length, they should be cut ¼ inch short to make sure that they do not extend beyond the plate line.

### Installation of Joists

When installing joists, you can save time by working in a systematic manner. After all joists are nubbed, and cut to length if necessary, they should be put up onto the plates in the approximate positions where they will be nailed. The joists should be left lying on their sides until you are ready to nail them in place. They should not be left standing on edge without being nailed in place, because they can cause a serious accident. Someone could step on the loose joists, trip, and fall to the floor 8 feet below.

Following layout of the studs on the top plate, each joist is nailed in position with three 8d nails at each end; two on one side and one on the other side. Do half of the building, and then proceed with the other half. The next joists will lap past the first joists at the center bearing partition. After each joist is toenailed into the plate with two 8d nails, three 16d nails should be driven through one joist and into the other. This nailing is important because it keeps the building from spreading.

Ceiling joists are not normally blocked, but to help prevent twisting, nail a 1 x 4 strip to the top of the joists at right angles to the joists. Two 8d nails should be used at each place where the 1 x 4 crosses a joist. These 1 x 4 strips, called "ribbands," or "catwalks," are nailed to gable-end studs or to the end rafters of a hip roof, or in some other way fastened to the outer edge of the building. Some builders prefer to use a "strongback" rather than a 1 x 4. The strongback performs the same function as the ribband, and it adds stiffness to the ceiling joist system. A strongback consists of a 2 x 4 that is nailed flat on top and at the midspan of the joists with two 16d nails at each joist and a 2 x 6 or 2 x 8 (on edge) that is nailed to the 2 x 4 with 16d nails on 16-inch centers.

### Installation of Backing

Backing must be installed at partitions and exterior walls that run parallel to the ceiling joists (Fig. 6-3). The purpose of backing is to provide a nailing surface for interior ceiling finish at the top of parallel walls. No backing is required between or at the ends of the joists, provided there is still enough ceiling finish material to span the distance. For joists on 16-inch centers, ½-inch Sheetrock is adequate; ⅝-inch Sheetrock should be used for joists on 24-inch centers. Plywood ¼ inch thick requires backing between the joist ends. Do not apply ¼-inch-thick plywood or other thin paneling directly to ceiling joists. From the standpoint of appearance and fire safety, it is better to apply ½-inch-thick Sheetrock first and then glue the plywood or other paneling to the Sheetrock. A few finish nails are used at the joists to keep the sheets in place until the glue has set sufficiently.

### Attic Access

An access hole, called a "scuttle," must be provided to the attic. If the building is designed so that there are two or more separate attic spaces, each space must have a scuttle. The scuttle must be at least 22 x 30 inches and must be located so that a person can readily climb into the attic. Also, the scuttle must be located away from the low portions of the sloping roof.

### Maximum Joist Spans

The method for determining maximum spans for joists was discussed in Topic 2. The maximum allowable spans for commonly used sizes of Douglas fir ceiling joists are given in Table 6-1.

Keep in mind that lumber longer than 20 feet may have to be special ordered and that you may have to pay an extra charge for every 1,000 board feet. Lengths greater than 26 feet are very difficult to obtain. No spans are given for DF No. 3, which is not strong enough to be used for ceiling joists.

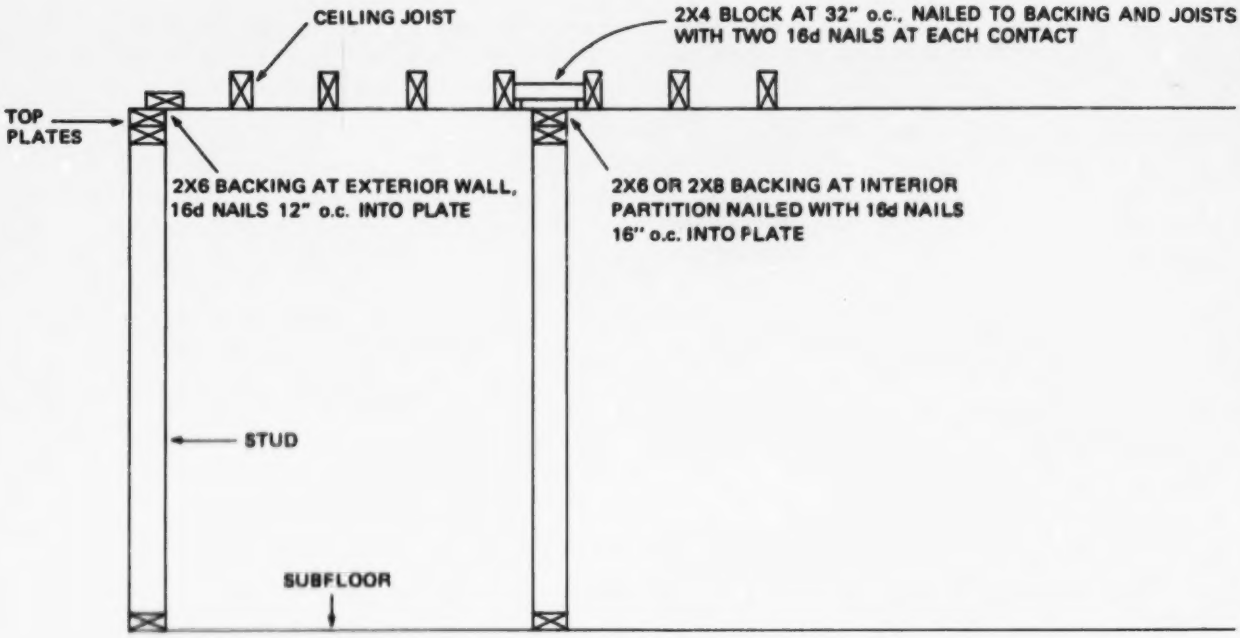

CEILING JOIST
2X4 BLOCK AT 32" o.c., NAILED TO BACKING AND JOISTS WITH TWO 16d NAILS AT EACH CONTACT
TOP PLATES
2X6 BACKING AT EXTERIOR WALL, 16d NAILS 12" o.c. INTO PLATE
2X6 OR 2X8 BACKING AT INTERIOR PARTITION NAILED WITH 16d NAILS 16" o.c. INTO PLATE
STUD
SUBFLOOR

**Fig. 6-3. Ceiling finish backing**

**TABLE 6-1**
**Allowable Spans for Douglas Fir Ceiling Joists**

| Size | Spacing | DF No. 2 | DF No. 1 |
|---|---|---|---|
| 2 x 4 | 12" | 12' 8" | 12' 11" |
| | 16" | 11' 6" | 11' 9" |
| | 24" | 10' 0" | 10' 3" |
| 2 x 6 | 12" | 19' 11" | 20' 3" |
| | 16" | 18' 1" | 18' 5" |
| | 24" | 15' 9" | 16' 1" |
| 2 x 8 | 12" | 26' 2" | 26' 9" |
| | 16" | 23' 10" | 24' 3" |
| | 24" | 20' 10" | 21' 2" |
| 2 x 10 | 12" | 33' 5" | 34' 1" |
| | 16" | 30' 5" | 31' 0" |
| | 24" | 26' 6" | 27' 1" |

### Multistory Construction

In multistory buildings the spans given in Table 6-1 apply only to the ceiling of the top story. The ceiling joists for lower stories also serve as floor joists for the story above. Since these members carry a much heavier load, they must be larger for a given span. The spans for floor joists are given in *Dwelling Construction Under the Uniform Building Code.* The important differences in installation procedures, blocking, and bridging that apply to floor joists are discussed in *Fundamentals of Carpentry,* Vol. 2, *Practical Construction.*

### Flat-Roof Buildings

In buildings with flat roofs, the ceiling joists also act as rafters. The spans given in Table 6-1 are not applicable, because roof loads are greater than ceiling loads. The applicable tables in *Dwelling Construction Under the Uniform Building Code* should be used to find allowable rafter spans for flat roofs, or roofs with a pitch of 3 in 12 or less.

### Study Assignments

1. Durbahn and Sundberg, *Fundamentals of Carpentry,* Vol. 2, *Practical Construction* (Fifth edition). Review Chapter 4, "Wall and Floor Framing," and read Chapter 5, "Roof Framing."
2. *Dwelling Construction Under the Uniform Building Code* (1982 edition). Review "Framing—General," "Floor Construction," and "Roof Framing," pp. 18—20; Table 25-Q; and Table 25-A-1.
3. *CAL/OSHA, State of California Construction Safety Orders.* Read articles 3, 18, 19, 25, 26, 28, 29, 33, and 34.

## TOPIC 6 – CEILING JOISTS

### Study Guide

Determine the correct word for each numbered blank in the sentence, and write it in the corresponding blank at the right.

1. The most common spacing for ceiling joists is __1__ inches, but the building codes permit spacing of __2__ inches. — 1. _____ 2. _____

2. The advantage of having ceiling joist bays directly over __3__ bays is that it is easier to install plumbing __4__ and heating __5__ . — 3. _____ 4. _____ 5. _____

3. Because ceiling joists are not normally long enough to __6__ across the entire building, they must be __7__ over the center bearing partition. — 6. _____ 7. _____

4. Nailing ceiling joists to __8__ provides an important tie across the building. For this to be possible, ceiling joists must run __9__ to rafters. — 8. _____ 9. _____

5. If ceiling joists do not run parallel to __10__ , it is necessary to provide 2 x 4 __11__ across the building at a maximum spacing of __12__ o.c. — 10. _____ 11. _____ 12. _____

6. To prepare ceiling joists for installation, you must __13__ off one end so that the joist end will not protrude above the roof line. — 13. _____

7. Joists must be installed with the __14__ up or the __15__ will worsen. — 14. _____ 15. _____

8. To prevent ceiling joists from twisting, nail a __16__ strip to the top of the joists at right angles to them. — 16. _____

9. Backing provides a __17__ surface for interior ceiling finish at the tops of walls __18__ with the joists. — 17. _____ 18. _____

10. An access hole, called a __19__ , must be provided to the attic, and it must be at least __20__ by __21__ in size. — 19. _____ 20. _____ 21. _____

# Instructional Materials

### Materials Required for Each Apprentice*

*California Contemporary House Plans.* Sacramento: California State Department of Education, 1975. (Orders to: California State Department of Education, Publications Sales, P.O. Box 271, Sacramento, CA 95802.)

*CAL/OSHA, State of California Construction Safety Orders* (Current edition). Los Angeles: Building News, Inc. (Orders to: Building News, Inc., 3055 Overland Ave., Los Angeles, CA 90034.)

Durbahn, Walter, E., and Robert E. Putnam. *Fundamentals of Carpentry,* Vol. 1, *Tools, Materials, Practices* (Fifth edition). Chicago: American Technical Society, 1977. (Orders to: American Technical Publishers, 12235 S. Laramie Ave., Alsip, IL 60658.)

Durbahn, Walter, E., and Elmer W. Sundberg. *Fundamentals of Carpentry,* Vol. 2, *Practical Construction* (Fifth edition). Chicago: American Technical Society, 1977. (Orders to: American Technical Publishers, 12235 S. Laramie Ave., Alsip, IL 60658.)

*Dwelling Construction Under the Uniform Building Code* (1982 edition). Whittier, Calif.: International Conference of Building Officials. (Orders to: International Conference of Building Officials, 5360 S. Workman Mill Rd., Whittier, CA 90601.)

### Materials Recommended for Further Reference

Feirer, John L., and Gilbert R. Hutchings. *Carpentry and Building Construction.* New York: Charles Scribner's Sons, 1977. (Orders to: Charles Scribner's Sons, 597 Fifth Ave., New York, NY 10017.)

Sundberg, Elmer W. *Building Trades Blueprint Reading:* Part 1—*Fundamentals* (Fifth edition revised). Chicago: American Technical Society, 1972. (Orders to: American Technical Publishers, 12235 S. Laramie Ave., Alsip, IL 60658.)

Sundberg, Elmer W. *Building Trades Blueprint Reading:* Part 2—*Residential and Light Commercial Construction* (Second edition). Chicago: American Technical Society, 1974. (Orders to: American Technical Publishers, 12235 S. Laramie Ave., Alsip, IL 60658.)

*Uniform Building Code* (1979 edition). Whittier, Calif.: International Conference of Building Officials. (Orders to: International Conference of Building Officials, 5360 S. Workman Mill Rd., Whittier, CA 90601.)

Wagner, Willis H. *Modern Carpentry.* South Holland, Ill.: Goodheart-Willcox Company, Inc., 1979. (Orders to: Goodheart-Willcox Company, Inc., 123 W. Taft Dr., South Holland, IL 60473.)

*Use latest edition available.

# Course in Carpentry

# ROUGH FRAMING

## Tests

The following section contains objective tests for each topic of the workbook. The value of the tests depends to a great extent on the care taken by instructors and school supervisors in keeping them confidential.

Supervisors and instructors should feel free to modify the application of the workbook material and the tests to satisfy local needs. Also, instructors will probably supplement the information in the workbook with other material that they have developed, and they will need to augment the tests with questions based on any supplementary material they may use.

Instructors and supervisors should be aware that the test pages are perforated to facilitate removal of the tests, either individually or as a complete set, at the discretion of the instructor or supervisor.

# Rough Framing Tests

## TOPIC 1 – BASIC FRAMING SYSTEMS

Decide which of the four answers is correct, or most correct; then write the corresponding letter in the blank at the right.

1. Metal wall systems are used in commercial and industrial buildings because they are: 1. ____

   a. Cheaper than wood
   b. Easier to install
   c. Fireproof
   d. Load bearing

2. Balloon framing is seldom used today, because it is: 2. ____

   a. Old fashioned
   b. Too expensive
   c. Difficult to erect
   d. Weak

3. The principal advantage of balloon framing is that it: 3. ____

   a. Provides more work for carpenters
   b. Makes walls stiffer
   c. Can be used in multistory construction
   d. Minimizes shrinkage in the height of the building

4. Which one of the following terms is not applicable to framing? 4. ____

   a. Header
   b. Molding
   c. Studs
   d. Rough sill

5. Why is it difficult to run electrical wiring and plumbing pipes in post and beam framing? 5. ____

   a. The system does not include stud, attic, or crawl space.
   b. The walls are taller.
   c. Post and beam buildings are larger.
   d. Modular construction gives less flexibility.

6. What size header is commonly used in conventional framing? 6. ____

   a. 2 x 4
   b. 2 x 6
   c. 4 x 12
   d. 6 x 10

7. In which of the following structures are steel studs often used? 7. ____

a. Houses
b. Cabins
c. Hospitals
d. None of the above

8. Post and beam construction is often preferred for its: 8. ____

a. Aesthetic value
b. Economy
c. Strength
d. Safety considerations

9. Steel stud systems are generally: 9. ____

a. Nonload bearing
b. For separation of space
c. Used in commercial construction
d. All of the above

10. What framing system is most widely used today? 10. ____

a. Balloon
b. Post and beam
c. Platform
d. Modified post and beam

## ROUGH FRAMING TESTS

### TOPIC 2 – FRAMING LUMBER

Decide which of the four answers is correct, or most correct; then write the corresponding letter in the blank at the right.

1. Ordering specified lengths for ceiling joists offers the advantage of: 1. ____

   a. Eliminating waste
   b. Ensuring correct lengths
   c. Being the cheapest way to order
   d. All of the above

2. Which of the following kinds of lumber is the strongest? 2. ____

   a. No. 1 redwood
   b. No. 1 white fir
   c. No. 1 Douglas fir
   d. No. 1 hemlock

3. Which of the following lumber grades is the strongest? 3. ____

   a. Dense No. 2
   b. Number 2
   c. Appearance or No. 1
   d. Number 3

4. The grade of a piece of lumber is determined by: 4. ____

   a. Size of knots
   b. Location of knots
   c. Other defects
   d. All of the above

5. Lumber grades are determined by: 5. ____

   a. Federal government standards
   b. Eye or machine
   c. Building inspectors
   d. Lumber dealers

6. What is the cheapest way to obtain 100 pieces of 2 x 6 that are 7 feet long? 6. ____

   a. Order from stock on hand.
   b. Cut 50 pieces of 14-foot-long 2 x 6s into 7-foot lengths.
   c. Cut 200 pieces from 2 x 6s that are 14 feet long.
   d. Order 100 8-foot lengths and cut 1 foot off each piece.

7. The abbreviation "S4S" means: 7. ____

   a. Sawed on four sides
   b. Surfaced on four sides
   c. Sized on four sides
   d. Smooth on four sides

8. When logs are first cut at the sawmill, the resulting lumber is in: 8. ____

   a. Nominal or rough dimensions
   b. Finish dimensions
   c. A very dry state
   d. None of the above

9. Which of the following can be used in place of redwood for mudsills? 9. _____

   a. Hemlock
   b. White fir
   c. Larch
   d. Pressure-treated fir

10. Which of the following types of framing lumber is used most frequently in the West? 10. _____

   a. Larch
   b. Hemlock
   c. White fir
   d. Douglas fir

## ROUGH FRAMING TESTS

### TOPIC 3 – HORIZONTAL LAYOUT

Decide which of the four answers is correct, or most correct; then write the corresponding letter in the blank at the right.

1. For sliding bypass doors how much should be allowed for the overlap of the doors? 1. ____

   a. 1″
   b. 2″
   c. 3″
   d. 4″

2. The maximum spacing allowed in the *Uniform Building Code* for studs in single-story houses is: 2. ____

   a. 18″
   b. 20″
   c. 22″
   d. 24″

3. If plywood or other modular paneling is to be installed on the exterior of the building, where should the first stud be located in relation to the building? 3. ____

   a. 16 inches from the outside edge of the building to the inside edge of the stud
   b. 15¼ inches from the outside edge of the building to the inside edge of the stud
   c. 48 inches from the outside edge of the building to the inside edge of the stud
   d. 96 inches from the outside edge of the building to the inside edge of the stud

4. Why is it desirable to line up stud bays with ceiling joist bays? 4. ____

   a. To make it easier for the plumber or other workers to install pipes, ducts, or flues
   b. To save time in locating ceiling joists (because the same layout previously used for studs can be used)
   c. To make the building stronger
   d. All of the above

5. What is the best method for determining rough opening dimensions for windows? 5. ____

   a. Consult the window supplier.
   b. Add 2 inches to the finish dimension of the window.
   c. Measure the frame size and subtract 1 inch.
   d. None of the above.

6. For most hinged interior doors, the rough opening width is: 6. ____

   a. The same as for the finish size of the door
   b. 3 inches wider than the finish dimension of the door
   c. 2½ inches wider than the finish dimension of the door
   d. 2 inches wider than the finish dimension of the door

7. The most common spacing for studs is: 7. ____

   a. 24″ o.c.
   b. 20″ o.c.
   c. 18″ o.c.
   d. 16″ o.c.

8. In plating why is it important to decide which way to lap the corners? 8. ____

   a. To save material (plate stock)
   b. To expedite installation of joists
   c. To determine the sequence in which the walls should be framed
   d. None of the above

9. Which of the following measuring devices is the most accurate to use in layout? 9. ____

   a. Cloth tape
   b. Framing square
   c. Level
   d. Steel tape

10. The purpose of snapping chalk lines on the subfloor is to mark the: 10. ____

   a. Centerlines of all walls
   b. Edges of all walls
   c. Outside edges of exterior walls
   d. Locations of door and window openings

## ROUGH FRAMING TESTS

## TOPIC 4 – VERTICAL LAYOUT

Decide which of the four answers is correct, or most correct; then write the corresponding letter in the blank at the right.

1. Using cripple studs 2 inches or shorter is not recommended, because they: 1. ____

   a. Interfere with installation of prehung door units.
   b. Are difficult to install.
   c. Tend to split.
   d. Are structurally inadequate.

2. A story pole is used most often in: 2. ____

   a. Multilevel or split-level construction
   b. Single-story construction
   c. Cabin construction
   d. None of the above

3. What scale is used to lay out a story pole? 3. ____

   a. ¼ c. ¾
   b. ½ d. Full scale

4. The length of trimmers for 4 x 12 headers in a standard height building is: 4. ____

   a. 80" c. 80½"
   b. 80¼" d. 80¾"

5. In conventional framing a 4 x 10 header gives the correct rough opening height for: 5. ____

   a. Standard swinging doors c. Pocket doors
   b. Bifold doors d. Accordion and bypass doors

6. In conventional framing a 4 x 12 header gives the correct rough opening height for: 6. ____

   a. Standard swinging doors c. Accordion and bypass doors
   b. Bifold doors d. All of the above

7. Why are 4 x 12 headers used in conventional framing? 7. ____

   a. The size is necessary for strength.
   b. They are cheaper in terms of labor and materials.
   c. It makes more work for carpenters.
   d. The electricians prefer 4 x 12s.

8. In conventional framing the standard stud length is: 8. ____

a. 92″
b. 92¼″
c. 92½″
d. 92¾″

9. The standard wall height in conventional framing is: 9. ____

a. 8′ 0″
b. 8′ ½″
c. 8′ ¼″
d. 8′ 1¼″

10. What part of the plans gives the sizes and types of doors and windows? 10. ____

a. Tables
b. Schedules
c. Lists
d. Items

## ROUGH FRAMING TESTS

### TOPIC 5 – ERECTING FRAMED WALLS

Decide which of the four answers is correct, or most correct; then write the corresponding letter in the blank at the right.

1. Ceiling joists or trusses should never be installed before the building is plumbed and aligned, because: 1. ____

   a. It is contrary to accepted practice.
   b. Trusses or joists interfere with nailing on doublers.
   c. The building cannot be racked after joists and trusses have been installed.
   d. All of the above.

2. In plumbing a building, you should use a straightedge because: 2. ____

   a. It takes longer than just using a carpenter's level.
   b. Bowed studs can cause errors.
   c. The *Uniform Building Code* requires the use of a straightedge.
   d. It is not safe to use any other method.

3. Before nailing down bottom plates, make sure that: 3. ____

   a. The bottom plate is properly aligned with the chalk line.
   b. The bottom plate is correctly positioned from right to left.
   c. No gaps exist between sections of the bottom plate.
   d. All of the above.

4. Let-in bracing can be omitted in: 4. ____

   a. All walls if exterior sheathing is used
   b. Interior walls if exterior sheathing is used
   c. Exterior walls if exterior sheathing is used
   d. Exterior walls if exterior sheathing of approved type and nailing is used

5. Doublers should be installed: 5. ____

   a. While the wall is still lying on the subfloor
   b. After all walls are raised into position
   c. At any time
   d. After ceiling joists are in place

6. How many and what size nails must be used to nail trimmers to king studs? 6. ____

   a. Two 16d
   b. Three 16d
   c. Five 16d 24" o.c. maximum
   d. Six 16d 16" o.c. maximum

7. How many studs are used in framing corners or partitions and intersections? 7. _____

a. One
b. Two
c. Three
d. Four

8. In installing temporary bracing while framing walls: 8. _____

a. Use only as many braces as are necessary for safety.
b. Use as many braces as needed to make sure the walls will not fall.
c. Brace the wall every 4 inches.
d. Avoid using braces, because it is time consuming to install them.

9. How many and what size nails are required where double top plates lap? 9. _____

a. Three 16d
b. Two 16d
c. Two 8d
d. Three 8d

10. The easiest and fastest way to frame walls is to nail which of the following parts together while the wall is still on the subfloor? 10. _____

a. Plates, studs, and headers
b. Plates and studs
c. Plates, studs, headers, and window sills
d. All of the above framing members

## ROUGH FRAMING

### TOPIC 6 – CEILING JOISTS

Decide which of the four answers is correct, or most correct; then write the corresponding letter in the blank at the right.

1. In flat roof building construction, which of the following is (are) true? 1. ____

   a. Ceiling joists also serve as rafters.
   b. Roof loads are greater than ceiling loads.
   c. Construction procedures are different because there is no attic.
   d. All of the above.

2. In multistory construction which of the following is (are) true? 2. ____

   a. Ceiling joists carry a much heavier load.
   b. Ceiling joists are larger for a given span.
   c. Ceiling joists for lower stories also serve as floor joists for the story above.
   d. All of the above.

3. No. 3 Douglas fir is: 3. ____

   a. Commonly used for ceiling joists because it is cheaper
   b. Not strong enough to be used where there are snow loads
   c. Commonly used because it is stronger than No. 1
   d. Not strong enough to meet the requirements of the *Uniform Building Code* for ceiling joists

4. Access to the attic is provided by a: 4. ____

   a. 24″ by 24″ scuttle
   b. 22″ by 28″ scuttle
   c. 22″ by 30″ scuttle
   d. Trap door of any size

5. The purpose of backing at the top of partitions that run parallel to joists is to: 5. ____

   a. Help keep doublers in place.
   b. Provide a nailing surface for exterior sheathing.
   c. Provide a nailing surface for interior ceiling finish.
   d. Keep the partition from bending.

6. To help prevent twisting of ceiling joists: 6. ____

   a. Install 1 x 4 ribbands.
   b. Install a strongback.
   c. Install blocking at all bearing points.
   d. Buy the best grade of material.

7. How many and what size nails are required for nailing a joist to a plate? 7. ____

a. Two 8d
b. Three 8d
c. Four 8d
d. Three 16d

8. When nubbing off ceiling joists, you should: 8. ____

a. Work carefully.
b. Pay no attention to the crown.
c. Always nub the edge of the joist that is crowned.
d. Nub both ends.

9. Ceiling joists should run: 9. ____

a. Perpendicular to rafters
b. Perpendicular to studs
c. Parallel to rafters
d. Parallel to floor joists

10. The most common spacing for ceiling joists is: 10. ____

a. 12″ o.c.
b. 16″ o.c.
c. 24″ o.c.
d. 48″ o.c.